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PANORAMIC ATTITUDE SENSOR

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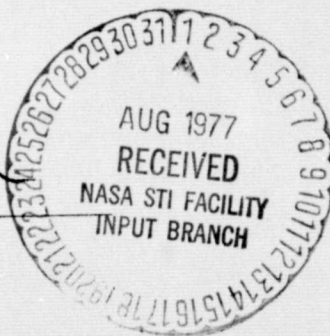
December 1976
Final Engineering Report

Prepared for
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16. Abstract This Final Engineering Report contains a detailed functional description of each subassembly, design analysis and final calibration data on all assemblies for the Panoramic Attitude Sensor (PAS). The PAS is used for course attitude determination on the International Ultraviolet Explorer Spacecraft (IUE). The PAS contains a sun sensor which is sensitive only to the sun's radiation and a mechanically scanned sensor which is sensitive to the earth, moon and the sun. The signals from these two sensors are encoded and sent back in the telemetry data stream to determine the spacecraft attitude.			
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1.0 SCOPE

This Final Engineering Report of the Panoramic Attitude Sensor (PAS) was prepared as part of the requirements for Contract No. NAS5-20651. It contains the following subjects:

- 1.1 DETAILED FUNCTIONAL DESCRIPTION OF EACH UNIT INCLUDING IDENTIFICATION OF FAULT DETECTION AND ISOLATION TECHNIQUES
 - 1.2 ANALYSIS FOR THE DESIGN CONSIDERATIONS AND THE DESIGN APPROACH IN PRODUCING THE OVERALL ASSEMBLY
 - 1.3 SUMMARY FOR THE DESIGN CONSIDERATIONS AND DESIGN APPROACH IN PRODUCING THE OVERALL ASSEMBLY
 - 1.4 FINAL CALIBRATION DATA ON ALL ASSEMBLIES
- 2.0 FUNCTIONAL DESCRIPTION AND FAULT ISOLATION AND DETECTION TECHNIQUES

The PAS system consists of two subassemblies. The instrument assembly, also known as the scanner head, is illustrated in Figure 1. The scanner head is connected to the other subassembly, the electronics assembly, by means of a cable which supplies electrical power and the control signals. The electronics assembly is illustrated in Figure 2. The sensor head contains a sun slit detector and preamp, a scanner detector and preamp, a heater circuit, a stepper motor and associated encoder, and the interface drivers to interface these circuits with the electronics assembly. The electronics assembly consists of two compartments. The smaller compartment is sealed to contain the electrical noise from the power inverter. This compartment contains only the power supply. The other compartment contains the stepper motor driver circuitry, the control logic, and the interface circuits to the spacecraft. This circuitry is contained on two stitchwelded circuit boards.

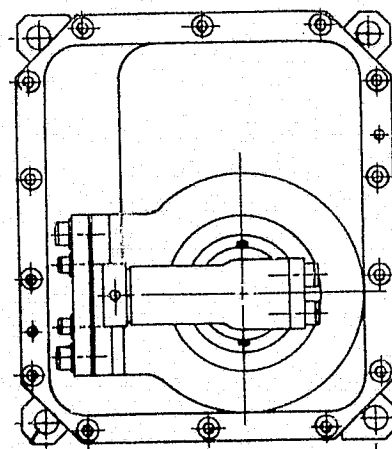
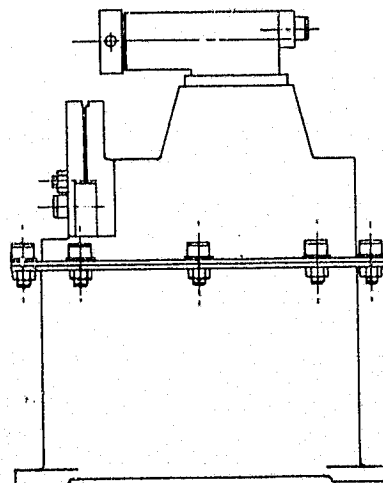


Figure 1
INSTRUMENT ASSEMBLY

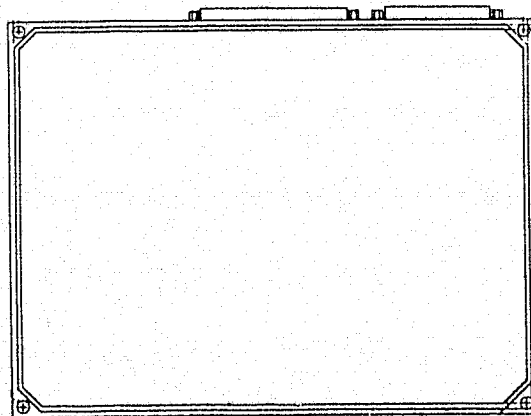
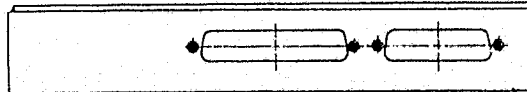
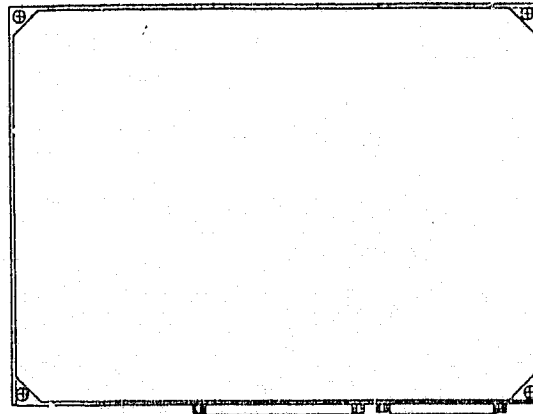


Figure 2
ELECTRONICS ASSEMBLY



2.1 MECHANICAL DESCRIPTION

The scanner head is housed in a small aluminum box with the mechanically rotated optical assembly on the top. It weighs slightly greater than 0.5 kilogram. The scanner head mechanism consists of a 45 degree stepper motor that drives the optical assembly through a 64:1 gear train in four passes of 4:1 gear reduction. The final gear is an antibacklash spring loaded gear which reduces the angular uncertainty to less than 0.1° .

The optical assembly is driven at variable rates depending upon the mode and command status from 78 steps per second down to 10 steps per second or slower. Ball bearings are used on the stepper motor gear train shafts and optical assembly. The housing is not hermetically sealed. Ball bearings and gears are lubricated with a proprietary lubricant (Vac Kote) which functions in a hard vacuum without evaporation. The electronics assembly is a rectangular box designed so that it can be stacked with similar units in the spacecraft. The power supply compartment contains a power supply printed circuit board mounted on standoffs with an aluminum cover to seal the compartment. The other compartment is open and contains two circuit boards with interconnecting wiring between the boards and the output connectors. The electronics components on these boards are soldered or welded on one side and interconnected on the other side by means of stitch-weld wiring. All of the components on the stitch-weld circuit boards are accessible by removing the four screws holding down the top board. Drawings of the two major assemblies, 48001 and 48557 are a part of Appendix A.

2.2 HEATER CIRCUIT

The heater circuit is used for thermal control of the scanner head. It switches on at a temperature between -10°C and $+15^\circ\text{C}$. It turns off at a temperature between $+5^\circ\text{C}$ and -5°C . The heater circuit is enabled with the application of spacecraft



28 volt DC power to the PAS assembly. This heater circuit is tied directly to the spacecraft 28 volt buss. When the heater is on, an additional 2 watts of power is dissipated in the scanner head. A schematic diagram of the entire head electronics is located in Appendix A as drawing 48572. The heater circuit is a part of this schematic. A simplified heater circuit is shown as Figure 3. The 28 volt power shown connected to the 390 ohm 5 watt heater resistor is completely isolated from the power operating the PAS electronics by the inverter transformer in the power supply. R1 and C1 provide a power supply bypass filter network to supply the amplifier and thermistor bridge circuit. The input voltage to the bridge circuit is further regulated at 20 volts with zener diode VR1. R2 provides the current limit for the zener diode.

Thermistor RT2 which has a nominal resistance of 10K ohm at room temperature has a resistance of approximately 30K ohm at 0°C and 54K ohm at 12.5°C. As a resistance the thermistor varies with temperature, a current unbalance is created at the input of op-amp AR1. Resistor R4 provides positive feedback causing the op-amp to act as a comparator with a hysteresis of approximately 12.5°C. The zener diode VR2 assures that no current can flow into the base of Q1 when op-amp AR1 is in its low stage which can be as high as +2 volts. Resistor R7 limits the current into Q1. Resistors R8 and R9 provide shunt paths for the leakage currents of Q1 and Q2 respectively. Transistors Q1 and Q2 multiply the output current of AR1 to 72 milliamps. This current flows through the 390 ohm resistor heating the gear plate. Thermistor RT2 is mounted physically near the 390 ohm resistor and when it is heated approximately 0°C, it unbalances the bridge sufficiently to cause AR1 to trip off and the 72 milliamp current ceases to flow.

2.3 STEPPER MOTOR

The PAS stepper motor is a size 8 permanent magnet DC stepper motor housed in a metal magnetic can inside the sensor head. It has two 135 ohm windings with no common ground connection between them. It is operated in a four-phase



mode with a step angle of 45° . It was designed to operate in a hard-space vacuum. The motor is pulsed with 12.8 millisecond pulses of 20 volt amplitude, sequentially, to each of the leads while the unenergized leads are held at ground potential. The duty cycle of the motor varies from nearly 100% to approximately 12% depending upon the step rate. Since the dry lubricant provides very low friction, electrical damping is provided by shorting out the unenergized windings to ground. This reduces the overshoot and oscillation. A drawing of the stepper motor is included in Appendix A as drawing number 48035.

2.4 OPTICAL ENCODER

The optical encoder consists of three major parts; the first is three light-emitting diodes (LED)-phototransistor pairs mounted on a Vespel housing surrounding an encoder shaft. The encoder shaft is an extension of the motor gear pinion with slots and holes to block the light path between the LED and the phototransistor as the shaft rotates. The second part of the encoder is a six-stage electronic counter that increments one count, up or down, each revolution of the motor shaft depending upon the direction of rotation. The third part is an LED phototransistor pair mounted over the output gear. A hole in this gear allows the phototransistor to be activated once each revolution of the scanner. The output of this circuit, known as the zero reference circuit, is used to reset the electronic counter in the zero count position. The scan head makes 512 steps per revolution. This position is encoded as a nine-bit digital code. The output of the gear shaft encoder forms the three least significant bits of that code. The six bits of the counter, forming the most significant bits of the code is illustrated in Table 1. The three least significant bits are in Gray code, the six most significant are in binary code. The LED's are supplied current continuously from the 5 volt internal buss. The ≈ 910 ohm resistors in series with the LED's limit the current to approximately 3.7 milliamps. The values of these resistors are selected to set the proper operating point of the LED phototransistor pair with an allowance for degradation and



CLOCKWISE ROTATION				COUNTER CLOCKWISE ROTATION			
<u>Position</u>	<u>MSB</u>	<u>Code</u>	<u>LSB</u>	<u>Position</u>	<u>MSB</u>	<u>Code</u>	<u>LSB</u>
0	1	000000	000	0	0	000000	000
1	1	000000	001	511	0	111111	100
2	1	000000	011	510	0	111111	101
3	1	000000	010	509	0	111111	111
4	1	000000	110	508	0	111111	110
5	1	000000	111	507	0	111111	010
6	1	000000	100	506	0	111111	011
7	1	000000	100	505	0	111111	001
8	1	000001	000	504	0	111110	000
9	1	000001	001	503	0	111110	100
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
504	1	111111	000	7	0	000000	100
505	1	111111	001	6	0	000000	101
506	1	111111	011	5	0	000000	111
507	1	111111	010	4	0	000000	110
508	1	111111	110	3	0	000000	010
509	1	111111	111	2	0	000000	011
510	1	111111	101	1	0	000000	001
511	1	111111	100	0	0	000000	000
0	1	000000	000	511	0	111111	100
1	1	000000	001	510	0	111111	101

When the PAS is in the PLANAR MODE, the Scanner Head position is represented by a hybrid Grey/Binary code. The three least significant bits are in grey code and the 7 other bits are in binary as shown below. The most significant bit is the direction of scan.

The seven Planar mode 10 bit words which are represented in this form are: AOS1, LOS1, AOS2, LOS2, AOS3, LOS3, and θ_e .

GREY CODE
Table 1



drift. The 20 volt buss is the source of power for the phototransistors and their associated buffers. The 20 volts is reduced to 10 volts by zeners in the scanner head. The phototransistors have 47K ohm load resistors so that at the switching point of the buffers, the load resistors, in combination with the impedance of the phototransistors, present a source of impedance of approximately 24K ohm. (See Figure 4) The buffers have 470K ohm feedback resistors providing a Schmitt trigger action. The ratio of feedback and source resistance provides a hysteresis of approximately .5 volt. The slots on the encoder pinion shaft are illustrated in Appendix A as drawing 48027. The slots are cut to provide the timing sequence, illustrated in Figure 5, when the shaft is rotating.

The signals from the three shaft encoder buffers labeled encoder A, encoder B, and encoder C, pass from the head through the cable into the electronics assembly. CMOS buffer U6 F, D and C, respectively, buffer the encoder signals as they come into the electronics assembly. The circuit is indicated on drawing 48574. Transitions of the encoder C line, causes the circuit composed U16D, U7E, R1 and C1 to act as a one shot which generates a positive pulse on either the negative or positive transitions of the encoder C line. This pulse is gated with the signal on the encoder B line using gate U6D and U56D, so that only the pulse that occurs when the encoder B line is high, causes a pulse in the clock inputs of the counter composed of U30 and U42. The signal on the encoder C line coming out of gate U7E, is fed into the up/down input of the counters as a function of the direction of shaft rotation. The timing diagram for clockwise and counterclockwise rotation is illustrated in Figure 5.

The signal from the zero reference circuit is labeled HOME and comes into gate U6E. The signal on the HOME line and all three encoder lines will be zero when the scanner is positioned at the zero reference angle. The all zero input to OR gate U44B causes a positive pulse to be applied to the parallel enable input on the counters. This loads an all zero count which effectively resets the counter to zero.

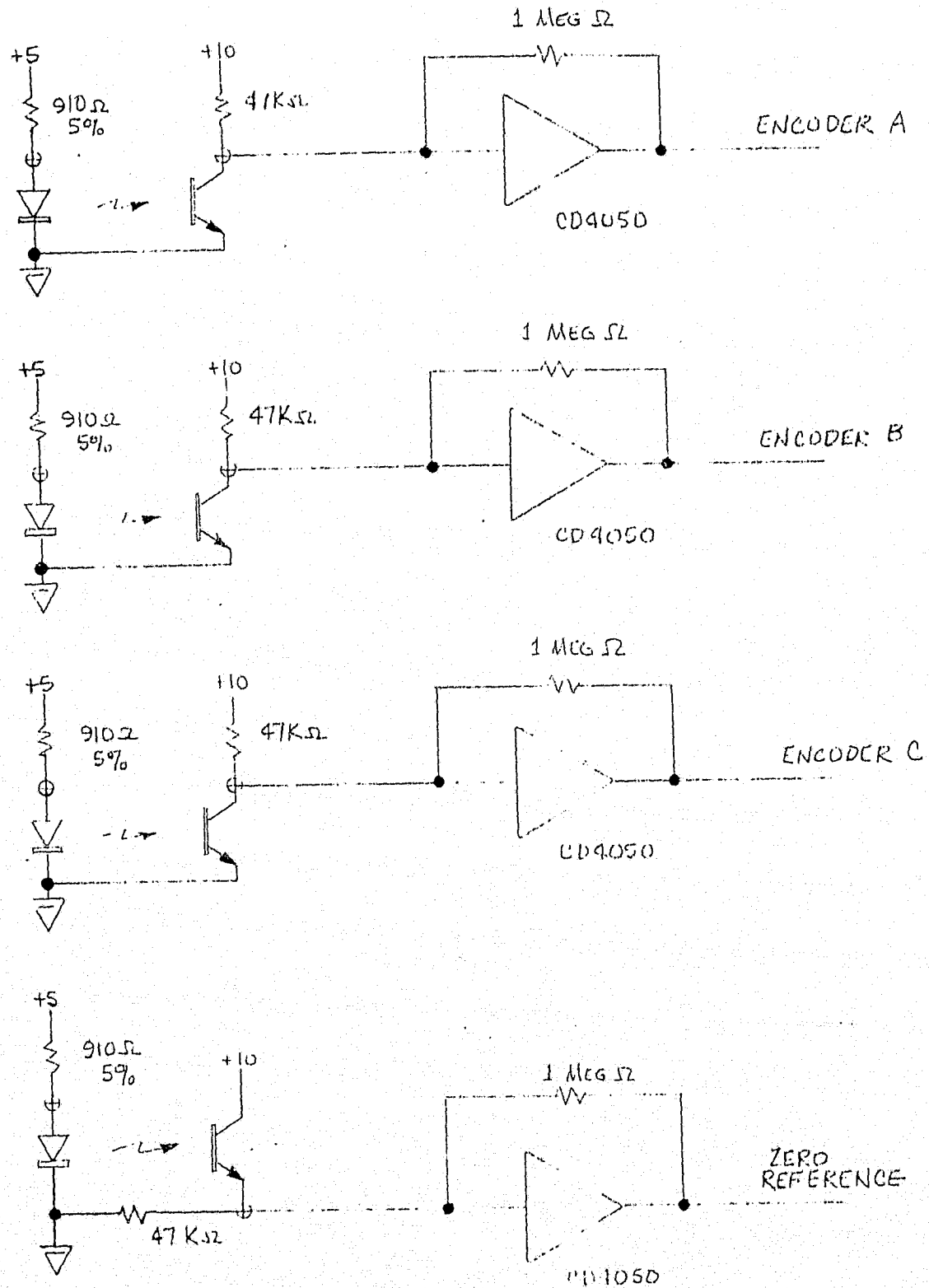


Figure 4
ENCODER CIRCUIT



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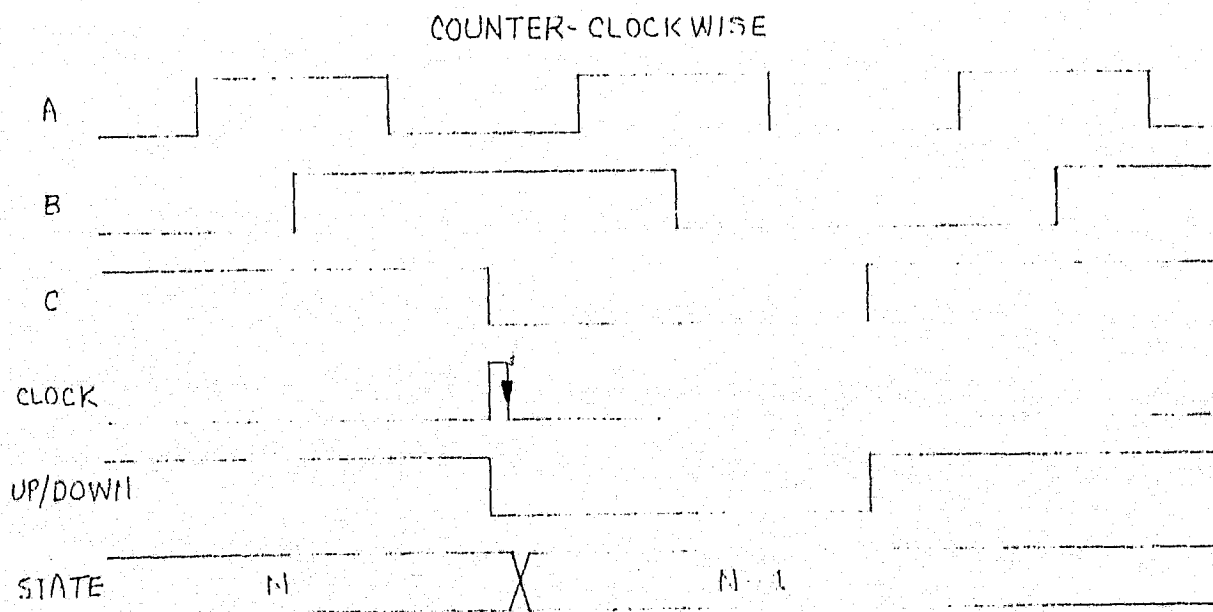
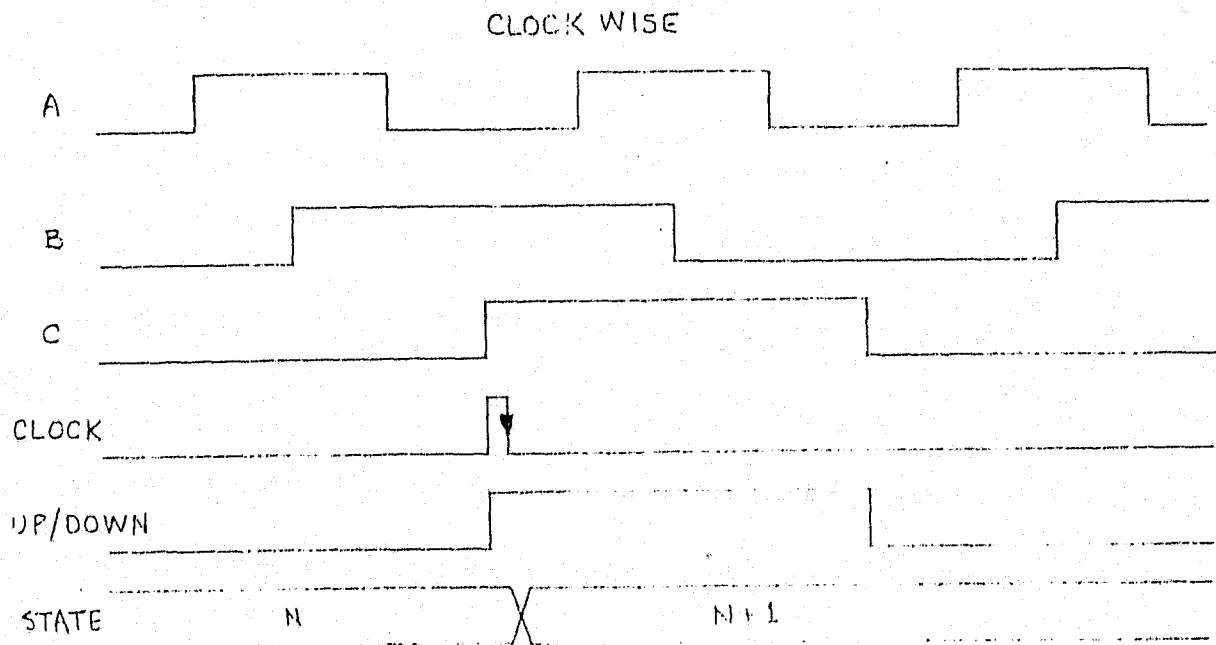


Figure 5
ENCODER TIMING

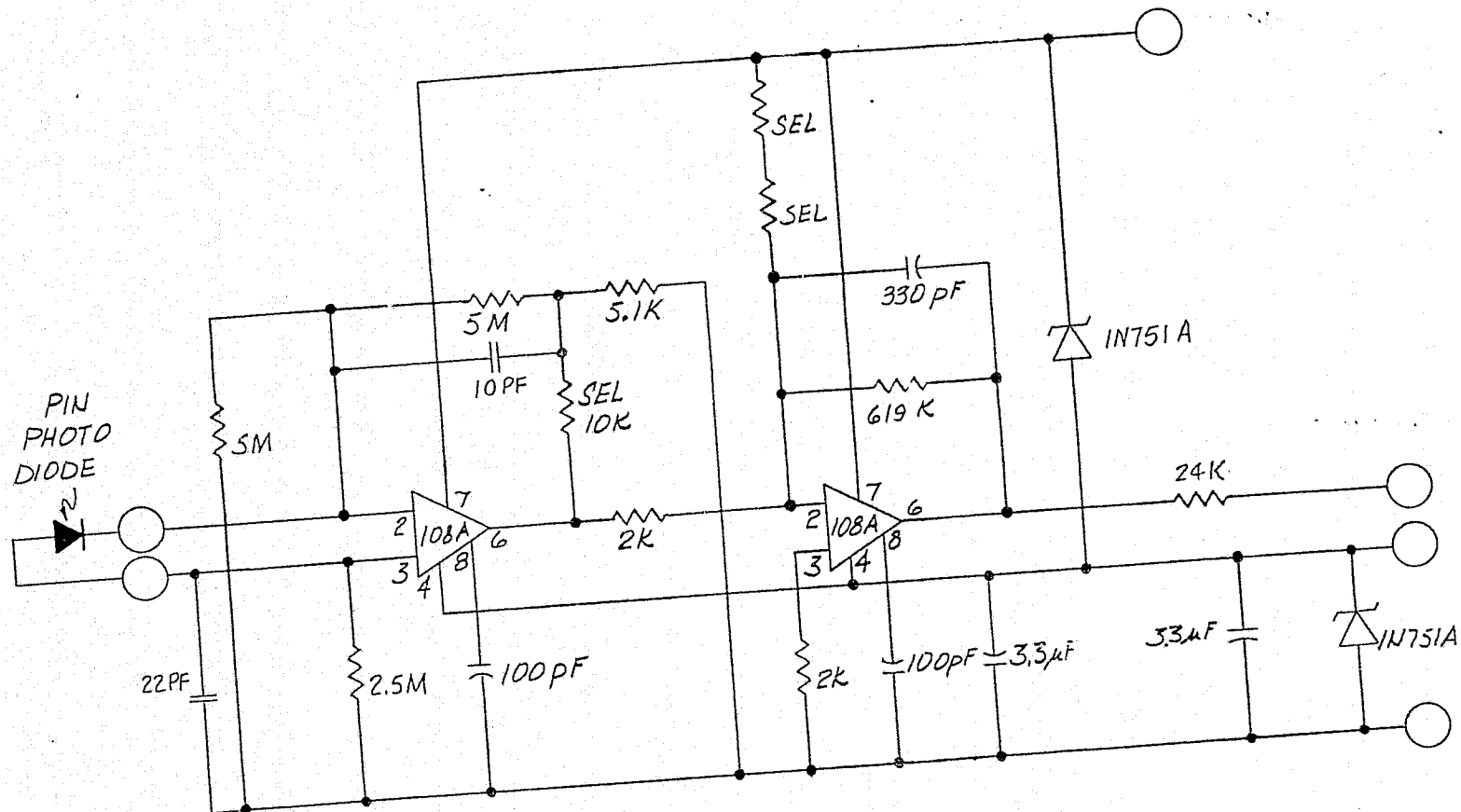


Figure 6
SCANNER PREAMPLIFIER





2.5 SCANNER OPTICS DESCRIPTION

The scanner optics assembly consists of a baffle assembly mounted on a rotating shaft. The scanner rotates about an axis perpendicular to the mounting plane of the sensor head. The scanner rotates in 512 steps of approximately 0.7° each step. The scanner head can rotate continuously through 360° of rotation or can sector through smaller angles as determined by the input command. The scanner field-of-view (FOV) is $0.7^\circ \pm 0.1^\circ$ diameter about the scan angle. Incoming light within this FOV is reflected 90° down the axis of rotation of the scanner shaft by a quartz prism. A convex quartz lens is cemented to the prism to focus the incoming light on a silicon PIN photodiode at the end of the optical shaft assembly. A 0.040 inch diameter aperture at the end of the shaft determines the FOV of the scanner. The active area of the silicon sensor is also 0.040 inch diameter which is aligned concentrically with the aperture and the end of the shaft. A data sheet of the detector is included in Appendix B. The sensitivity of the scanner preamp is controlled by a select resistor to trip at 0.1 of the intensity of a full moon when in earth orbit.

2.6 SCANNER ELECTRONICS

The PAS scanner preamplifier is a two-stage DC coupled amplifier using LM108A low power op-amps. The PIN photodiode Q1 operates in the photovoltaic mode with zero bias voltage. The output of Q1 is tied directly to the input of the first stage op-amp AR1. This stage acts as a transimpedance amplifier with a five megohm feedback resistor. R5 and select resistor R4 form a voltage divider network which raises the transimpedance to approximately 30 megohms. Capacitors C2 and C3 compensate for stray capacitance which would make the amplifier unstable. C1 is connected to the op-amp compensation pin. Figure 6 is a simplified schematic of both scanner stages. It is also a part of this head electronics, schematic 48572, which is located in Appendix A. The components of the first stage of the scanner preamplifier, including the PIN silicon photodiode, are mounted on circuit board A3 which is mounted near the end of the optical scanner shaft. The second stage of



the preamplifier is mounted on circuit board A2. This stage acts as an inverting voltage amplifier with a gain of approximately 310. R2 is the input resistor and R4 is the feedback resistor. C3 is in parallel with R4 which provides a rolloff at approximately 780 hertz. Resistor R3 biases the input near the no-signal output of the first stage op-amp and resistor R1 is a select resistor to offset the output near zero volts corresponding to no signal into the photodetector.

The output of the second stage op-amp flows through R5 and to CMOS buffer U1A, which is on board A1. R5 in combination with R11 converts the buffer into a Schmitt trigger with approximately .5 volt hysteresis.

2.7 SUN SLIT OPTICS

The sun slit assembly consists of two semi-circular aperture halves spaced approximately 0.004 inches apart forming an aperture with a fan shaped FOV slightly greater than $.5^\circ$ in a plane perpendicular to the axis of rotation by approximately 180° in a plane coincident with the axis of rotation of the spacecraft. The light passing through the sun slit strikes a grit-blasted aluminized cone which concentrates the light on the active area of a PIN silicon photodiode of the same type used in the scanner. The sun slit preamplifier is a single-stage transimpedance type with a 5 megohm feedback resistor, R9. Five megohm resistor R8 provides an offset bias to set the no signal output of level AR2 at near zero volts. Capacitor C6 provides a low frequency rolloff at approximately 470 hertz. R8 and R9 are selected to provide the proper sensitivity. C6 is selected accordingly to maintain the 470 hertz bandwidth. Resistors R6 and R7 are tied to the five volt bias supply which biases AR2 at the midpoint of its operating range. C4 provides a rolloff consistent with the network formed by R9 and C6.

2.8 ONE-HALF PEAK DETECTOR CIRCUIT

The output of AR2 feeds into a circuit composed of five transistors which senses when a trailing edge pulse from AR2 passes through one-half the



value of the peak signal amplitude. This one-half peak amplitude detector circuit assures that the sun crossing angle remains constant as the amplitude of the sun pulse varies according to orbit parameters. Resistors R10 and R11 form a voltage divider with an output equal to one-half the output of AR2. Q1 and Q2 are complimentary emitter followers whose output offset voltages cancel. The maximum voltage appearing at the junction of R10 and R11 charges capacitor C7 to one-half the peak amplitude of the sun pulse. This one-half amplitude pulse is supplied to one side of differential pair Q3 and the output of AR2 as applied to the other side. Whenever the output of AR2 is greater than one-half the peak amplitude of the pulse, current flows through resistor R16 into the base of Q4 which in turn causes current to flow to R19 providing an output sun slit pulse. When the output of AR2 drops below one-half of the peak amplitude voltage stored in C7, Q4 is cut off causing the sun slit voltage to drop to near zero. Resistors R15 and R18 provide a discharge path for C7 and provide a minimum threshold of approximately 2.25 volts so that noise pulses will not be sensed by Q3 and Q4. The output of Q4 is buffered by U1D, which also acts as a Schmitt trigger. Figure 7 is a simplified schematic of the sun slit preamplifier. This circuit is also part of head electronics schematic 48572.

2.9 POWER SUPPLY

The PAS power supply schematic, 48561, is located in Appendix A. Twenty-eight volt spacecraft power enters the power supply compartment through an EMI filter labeled FL1. The 28 volt return is connected to a similar filter FL2. These are L section filters which attenuate electrical noise with a frequency component above approximately 10 kilohertz. The output of L1 is connected to the input filter capacitor C2. Diode CR1 is connected in parallel across L1 to limit the voltage transients when the power is switched off the 28 volt buss. The power supply converter is in two sections. The first section is a free-running square wave oscillator, powered from the output of L1. Also connected to the output of L1 is another inductor L2, which limits current transients to the output driver stage during

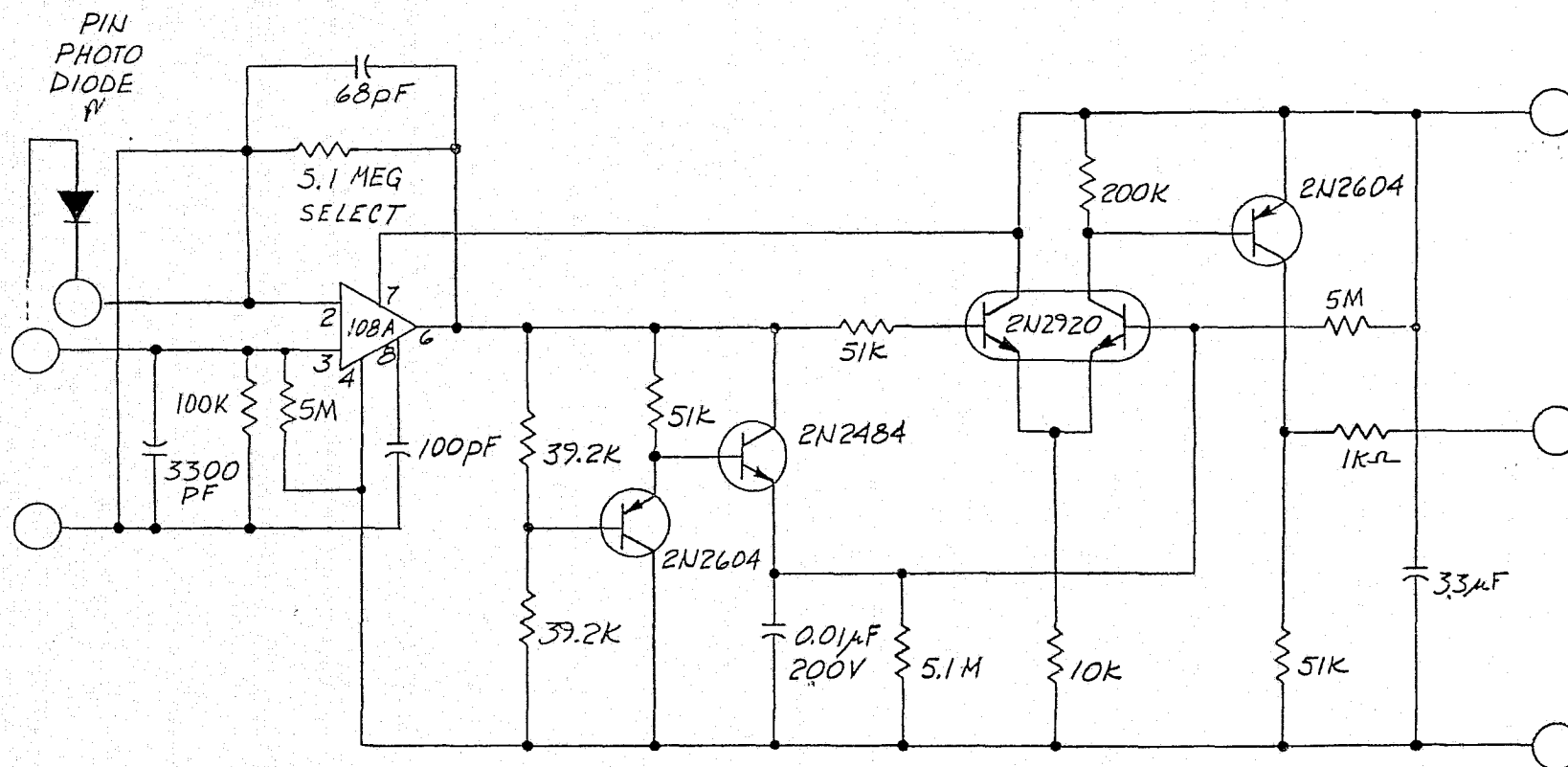


Figure 7
SUN SLIT PREAMPLIFIER





switching transitions. The output driver stage consists of transformer T2 and transistor Q4 and Q5. Q4 and Q5 are driven from the output of the control oscillator transformer T1 through speed-up networks consisting of R5 and C3, for the Q4 base, and for R6 and C4 for Q5's base. The control oscillator consists of transistors Q2, Q3, transformer T1, and base-limiting resistors R7 and R8. The frequency of oscillation is determined by the voltage level applied to T1 primary center tap E14. This reference voltage is generated by zener diode VR1. C1 is tied in parallel with VR1 to attenuate high frequency noise. The current through VR1 is regulated at 10 milliamps by FET transistor Q1 which is connected as a constant current source. Resistor R1 is selected during initial test to set the current through Q1 at 10 milliamps. Select resistor R3 and thermistor RT1 provide a temperature compensation network to offset the drift in frequency with temperature of the control oscillator, with the terminals E11 and E12 jumpered together to provide an oscillator frequency of 20 kilohertz. The jumper is then removed and resistor R2 is selected to provide an operating frequency of 19 kilohertz. The power supply frequency can be selected depending upon the mission requirements by removing the jumper between E11 and E12. Resistor R4 provides an offset current to enhance the starting characteristics of the oscillator at low temperatures. No additional regulation is included in the power supply. The secondary of transformer T2 has a winding for the 5 volt internal power buss and a winding for the 20 volt stepper motor power. The 5 volt supply is configured as a full-wave rectifier with CR6 and CR7. C6 acts as a filter for the switching transients. Likewise, CR4 and CR5 rectify the voltage for the 20 volt supply and C5 filters out the switching transients. Filter FL3, 4, 5, and 6 couple the power supply voltages through the compartment wall into the stitch-weld boards.

2.10 SPACECRAFT INTERFACE CIRCUITS

The signal input circuits from the scan head and the spacecraft are illustrated in zone 12 of drawing 48569. All of the input circuits are similar with a



terminating resistor connected to the input of the CMOS buffer. The value of the terminating resistor varies from 1.8 K ohm to 62 K ohm depending upon the source impedance and the data rates. The signals associated with the telemetry data, the input clock and the input command are redundant. The outputs of the 10 kilohertz buffers and the buffers associated with the telemetry word, word gate and shift pulse are OR'ed with OR gates U8B, C, D respectively, so that an open or short-to-ground of any input will not affect the operation of the unit. Similarly, the redundant inputs for command data and command clock are OR'ed with gates U9C and D. These inputs are enabled by the command envelope signal which is protected from opens, shorts-to-ground, shorts-to-power as well as buffer failures. A .1 micro-farad coupling capacitor in each channel prevents any steady state failure from blocking an input command.

2.11 POWER ON CLEAR CIRCUIT

The command envelope signal at the output of U8A is used to reinitialize the PAS electronics after each command. It also resets the power on clear latch composed of gates U7, B, and C. The power on clear latch is set on power application because capacitor C6 does not charge to U7B's input threshold until the 5 volt power has stabilized. The power on clear signal initializes the electronics and inhibits the stepper motor drivers until an input command is received. Diode CR9 discharges C6 when the power is removed to prepare the power on clear circuit for the next power on cycle.

2.12 TIMING CHAIN

The timing chain as well as most of the counters and flip-flops in the PAS are clocked synchronously from the 10 kilohertz clock line. U15 is a four



stage counter whose output states are decoded by the network composed of U29 A, B, and C and U30A. The four different combinations of the input command bits, rate MSB and rate LSB, divide the 10 kilohertz clock by 2, 4, 8 or 16. When the PAS is in the spherical mode, U31A is enabled, and the output of the counter and rate selection network is applied to the AOS (Acquisition of Signal) and LOS (Loss of Signal) timers. When the PAS is in the planar mode, U31A is disabled and the motor driver decoder network is enabled. The clock frequency is further divided by four stage counter U16 and by flip-flops U19 A and B. The pulse train out of U28D occurs at a 1 pulse per motor step rate. This pulse train is applied to U17 which is configured as a modulator four counter. It will count either up or down depending upon the voltage level on the direction input, pin 10, or is inhibited from counting if any of the inputs to U25D go to a low voltage level. The outputs of U17 are further decoded to a one-of-four output by gates U22A and B, U26B and U33A, B, and C.

2.13 MOTOR DRIVE

The output of each of these states goes to one of four identical motor driver circuits. These circuits are illustrated in zones 5 and 6 of drawing 48569. The input of each of these driver circuits is an inverting CMOS buffer driving R-C delay networks. The delay networks are made unsymmetrical by the connection of a series diode and low value resistor in parallel with the timing resistor. The output of each time delay network is connected to the input of a CMOS buffer. Noninverting buffer U5A, B, C or D provides the drive for a 2N222A and a 2N4239 transistor connected as a darlington pair. This circuit acts as the return current path for the energized winding as well as holding both leads of the unenergized winding shorted to ground potential. The unsymmetrical time delay circuit at the input causes a short delay in switching off, but a long delay in switching on. The transistor driver circuits connected to inverting buffers U1A, C, U11A, C provide the source current for the energized motor winding by pulling the energized motor phase to +20 volts. Only one motor phase is pulled to +20 volts at a time. The other three phases are held at ground potential. The



RC delay network at the input of the pull up circuit also provides a long delay at turn on and a short delay at turn off. These delay circuits cause the motor driver outputs to go to a high impedance state for approximately one-half millisecond before switching high or low. This delay allows the stored charge in the output transistors to dissipate before switching.

2.14 MODE SELECT CIRCUITRY

The PAS has two major modes of operation, spherical mode and planar mode. Most of the circuitry operates the same in both cases. However, some circuitry is configured according to the mode of operation. A quad 2-input multiplexer, U20, is the device that selects the mode configuration. The major functional differences between the spherical and planar mode are itemized in Table 2. Figure 8 is a simplified schematic showing the signal paths through the mode and selection multiplexer in the planar mode. The last stages of the timing chain are decoded by U28D. The width of the pulse from U28D is equal to one period of the 10 kilohertz clock. It's connected to the modulo four motor phase counter U17 through channel 2 of the multiplexer. This signal called SLOT F, is also connected to Θ MIN and Θ MAX angle comparison gate U13A and B, to strobe the encoder. If the encoder is at the Θ MIN angle, the output of U13A is a pulse called Θ MIN with the same timing as SLOT F. In the planar mode, this signal passes through channel 1 of the multiplexer. In Figure 8 it's labeled as CROSS and is shown connected to the reset of U4B, the target counter. The signal on CROSS occurs once each revolution or sector of the scan head and by resetting the target counter starts a new data acquisition cycle for the PAS. CROSS also sets a flip-flop called FIRST which controls the loading of data into the output buffer register and into a one-shot circuit composed of U21B and U32C and an R-C delay network. The output of this circuit called LOAD EDGE F is a short pulse that occurs at the leading edge of CROSS. This pulse loads the data acquired during the cycle into the output register. In the planar mode, the target data registers are updated by loading the encoder position once for each motor step pulse. To generate the signal called LOAD COUNTERS F, the timing chain output from U28B is AND'ed with the 10 kilohertz clock with gate U27D. The output of U27D passes through channel 3 of the multiplexer through one-shot circuit composed of U32D,



PLANAR

1. Data is loaded into the buffer at Θ MIN encoder angle.
2. Data at AOS/LOS is encoder angle.
3. Motor steps continuously at rate determined by timing chain.
4. New status word is loaded each telemetry word

SPHERICAL

1. Data is loaded into buffer at sun crossing.
2. Data is time interval between AOS/LOS and sun crossing.
3. Motor steps once each sun crossing.
4. New status word is loaded each sun crossing.

Table 2
PLANAR/SPHERICAL FUNCTIONS



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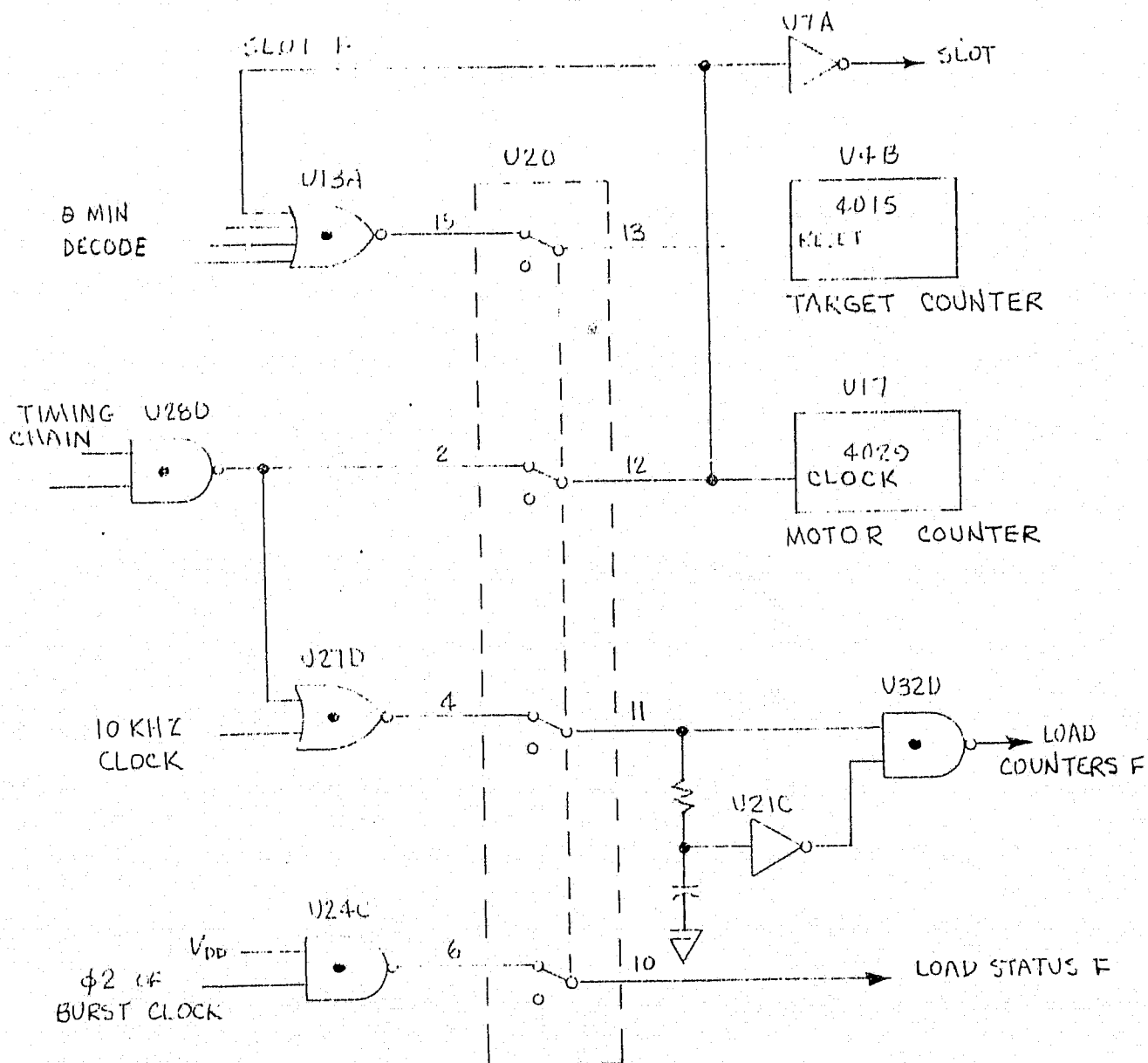


Figure 8
PLANAR MODE



U21C and R-C delay network. (See Figure 9.) The LOAD COUNTERS F pulse from U32D is a narrow pulse occurring after the falling edge of the 10 kilohertz clock. The first 16 bits of the status word, which includes the encoder position, are loaded at the beginning of each telemetry word transmission. The second pulse of a burst oscillator, which is triggered by the digital word gate input, and is buffered by U24C and selected by channel 4 of the multiplexer, is connected to the status registers by a line called LOAD STATUS F. The digital word gate occurs at the beginning of a telemetry word transmission.

The pulse out of channel 1 of the multiplexer U20 starts a new data acquisition cycle. In the planar mode, this signal comes from the θ MIN angle comparator circuit. However, in the spherical mode the channel 1 input of the multiplexer, connected to the sun slit edge decode circuit (U25A and U13A), is enabled causing the data acquisition cycle to start on the falling edge of the sun crossing. (See Figure 10.) The output of channel 1 of the multiplexer connects to the input of channel 2 through gate U24D. The pulse out of channel 2 causes the motor to step once for each sun crossing. If the telemetry rate is slower than the sun crossing rate, the input of U24D connected to the flip-flop FIRST inhibits the motor counter to step only on the FIRST sun crossing after each telemetry data word. The output of U24D goes through a one-shot circuit consisting of U21B and U32C to load the data and status in the output registers. The same sun crossing signal from U25A is connected to the input of U27A along with the 10 kilohertz clock to generate a LOAD ZERO pulse. The LOAD ZERO pulse forces the parallel inputs to the counters to all zeros. The same pulse passes through channel 3 of the multiplexer through a one-shot circuit, consisting of U21C and U32D, to provide the clock pulse to load the all zero state into the counter register. Figure 11 is a timing diagram of all of these signals.

2.15 LOADER CIRCUIT

The loader circuit provides the proper sequence to load the data word and the output register. The PAS contains two identical 80-bit registers. One of these is the data buffer register, which is loaded at the end of the data acquisition cycle. The other register is an output shift register that shifts out the data word when clocked by external shift pulses. These

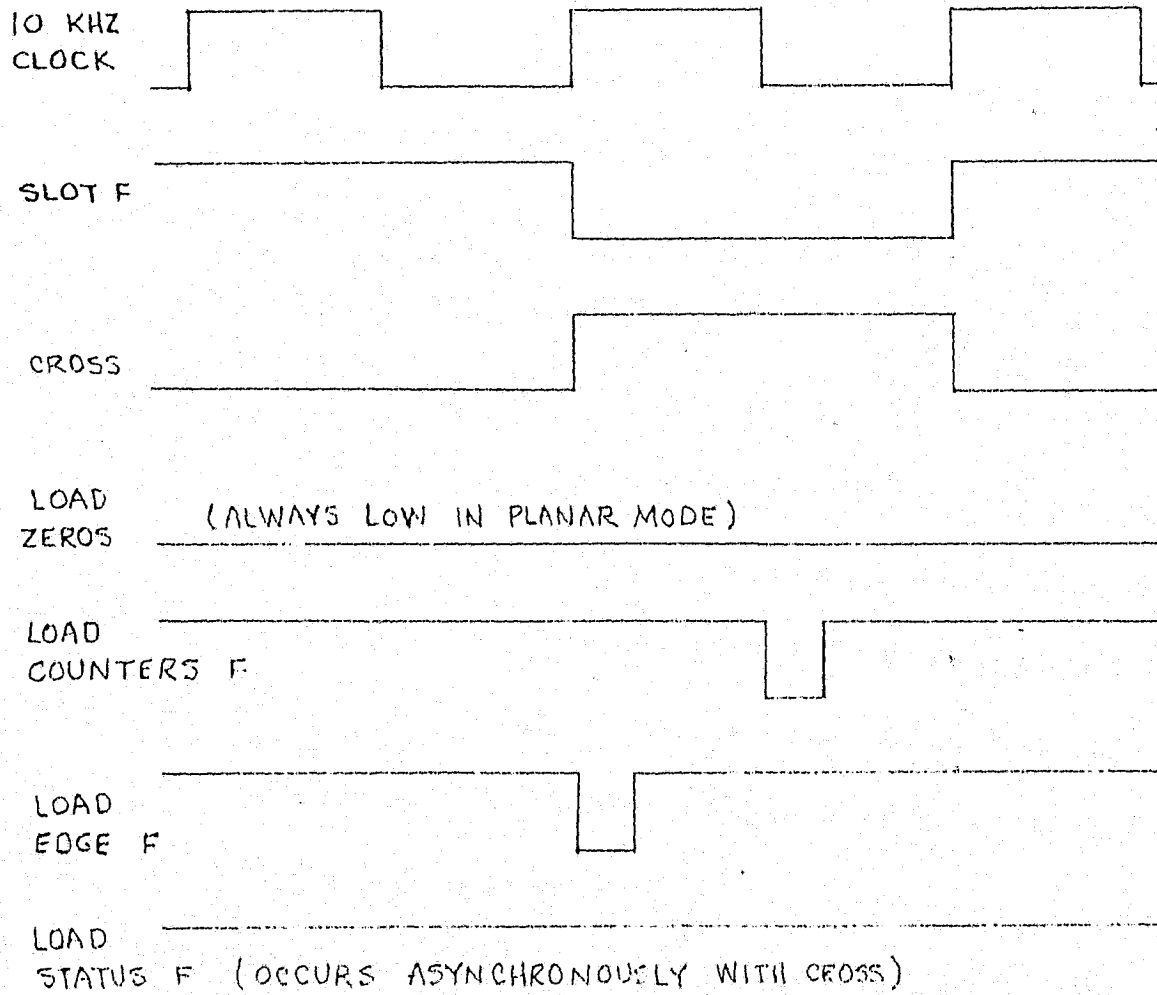


Figure 9
PLANAR MODE TIMING

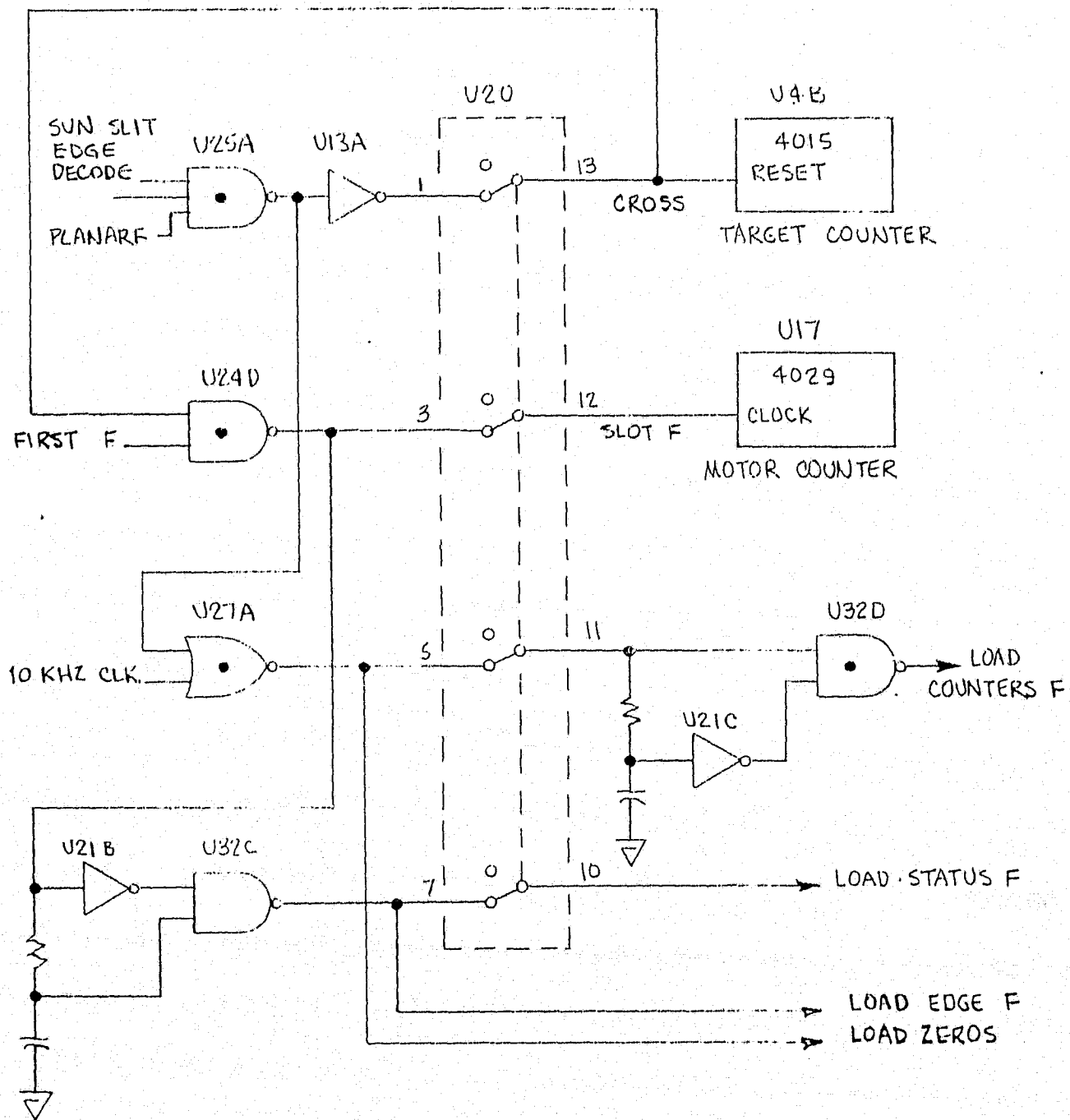


Figure 10
SPHERICAL MODE

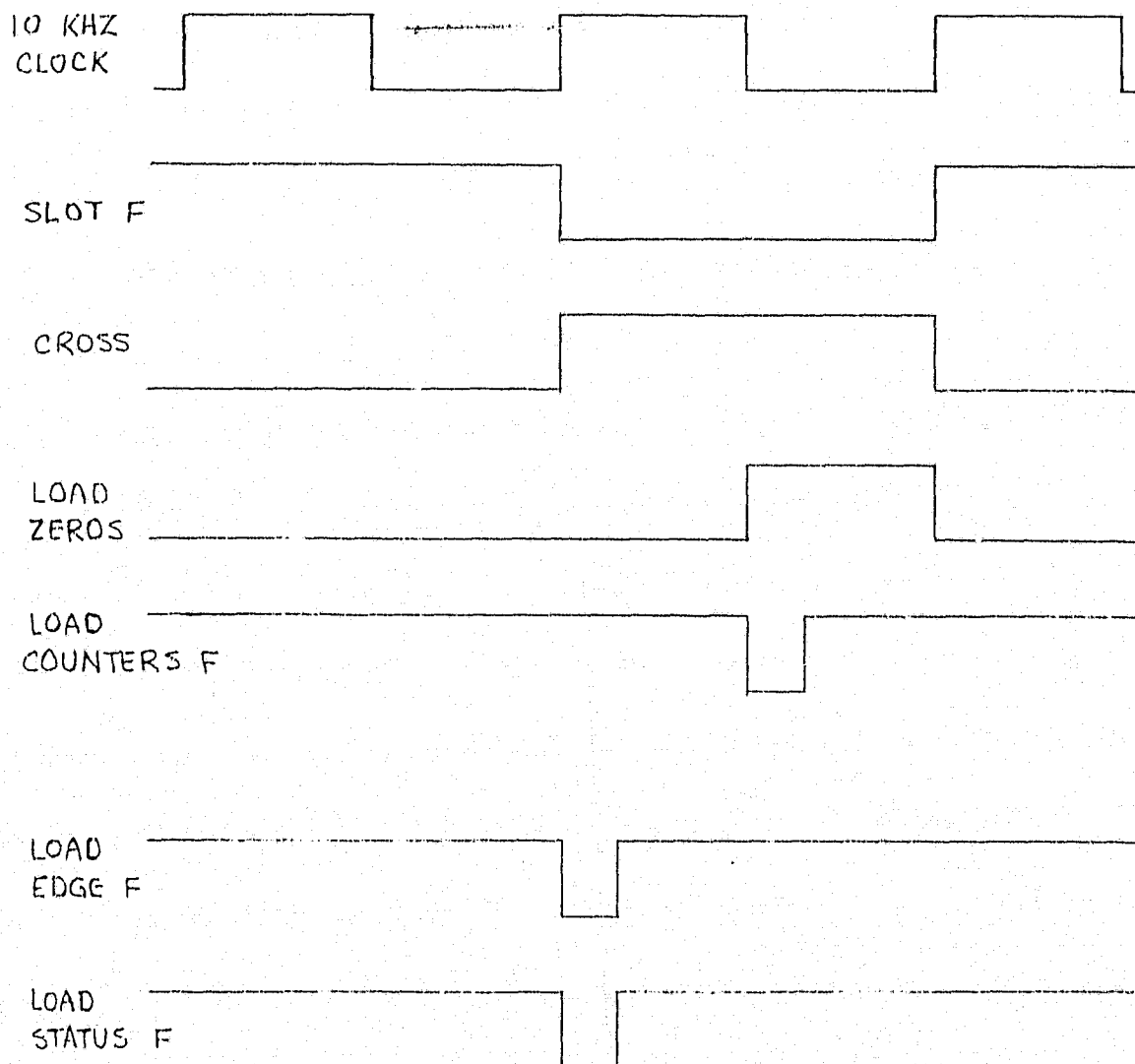


Figure 11
SPHERICAL MODE TIMING



registers switch functions at the end of each data acquisition/data readout cycle. Flip-flop U14B, labeled FLOP controls the functions of these two registers. Figure 12 illustrates the sequence of operation. The three states on the right correspond to FLOP being set to one, the three states on the left correspond to FLOP reset to zero. At power on, or at the receipt of an input command the PAS is put in the invalid state. This corresponds to flip-flop U12B being set. This sets a bit in the status word indicating invalid data. The first Θ MIN or sun crossing sets flip-flop U12A putting this system in the FULL state. In this state, the data buffer is full and it is ready to be loaded into the output register on receipt of a digital word gate. Any additional Θ MIN or sun crossings have no effect, and the data associated with that crossing is not stored. When a digital word gate occurs, a burst oscillator consisting of U26A, U13B and U13C generates four clock pulses to counter U18. After four clock pulses, the fourth stage goes to a one level inhibiting the burst oscillator. The output sequence of U18 corresponds to transferring from the FULL to the COUNTING state on the state diagram. The toggling of U14B causes the data buffer register to become the output shift register and the output shift register becomes available to load the data of the next data acquisition cycle. Data is recirculated in the output shift register so that multiple digital word gates repeat the data from the last Θ MIN or sun crossing.

2.16 DATA REGISTERS

The data registers are part of schematic 48574. U45 through U54 and U57 through U66 make up the data buffer and output shift registers. U21 through U29 and U33 through U31 form the counter register. In the planar mode, this register is loaded with encoder angles corresponding to target acquisition and loss. In the spherical mode, this register acts as six counters which contain counts corresponding to sun crossing and target acquisition and loss times. The target data is steered into the appropriate counter register segment by a network of gates connected to U4B, the target counter. This counter is a shift register which is stepped once for each transition of the



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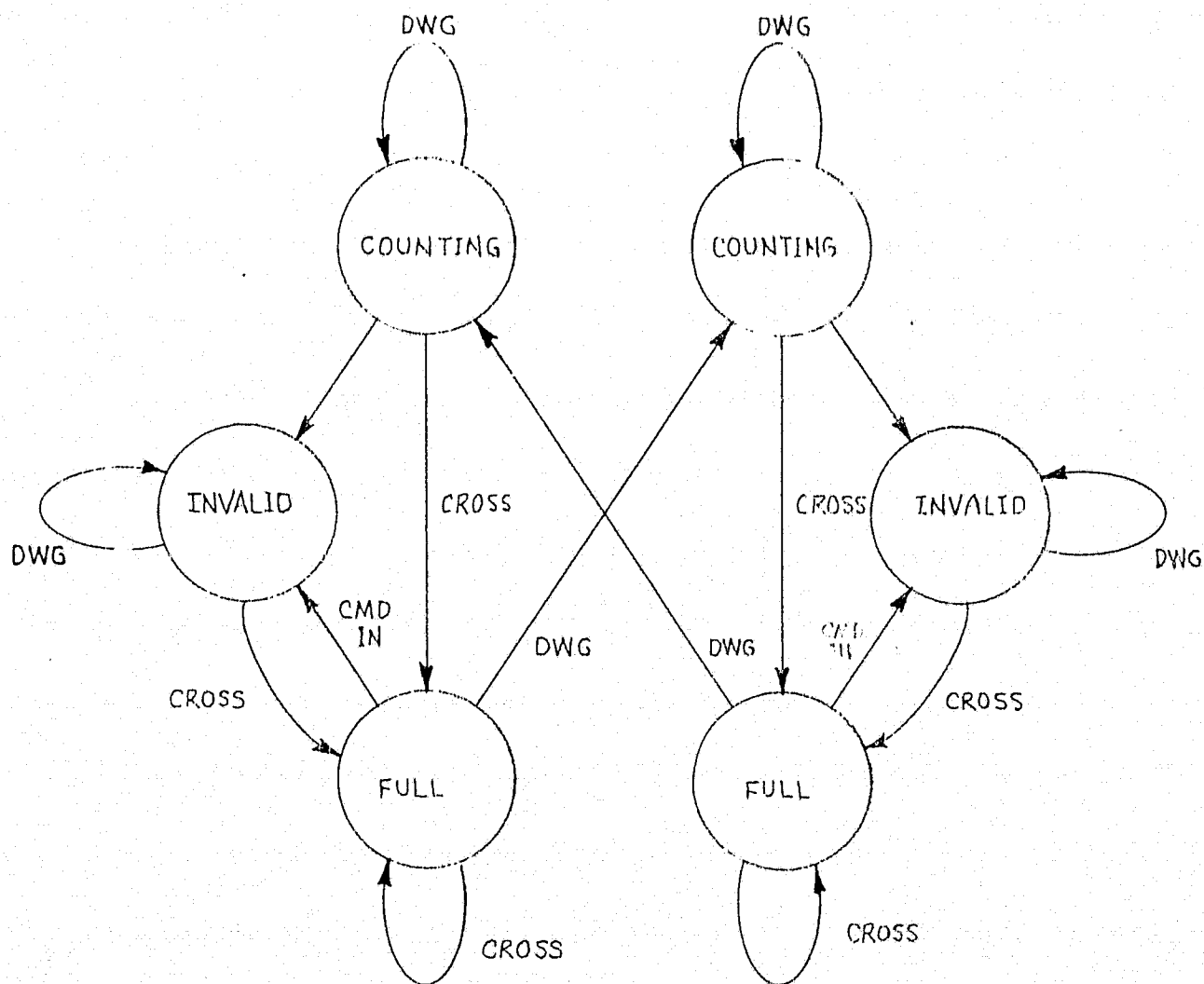


Figure 12
STATE DIAGRAM



scanner input. It is reset by a Θ MIN or sun crossing, depending upon the mode. The input command register consists of U1, U2, U3, and U4A. It contains enable bits for the various modes and functions as well as a Θ MIN and Θ MAX angle. The bit assignments for the data and command registers are listed in Tables 3 and 4.

2.17 Θ MIN AND Θ MAX COMMAND BITS

The Θ MIN and Θ MAX command bits are each connected to one side of an exclusive or comparator circuit. The other side of these angle comparator circuits, consisting of gates U9 through U16B, are connected to the encoder counter. When the motor steps the encoder around until the encoder angle matches the Θ MIN commanded angle, the output of U13A sets the direction flip-flop reversing the stepper motor. The direction flip-flop consists of cross-coupled NOR gates U44A and U55A. When the motor steps the encoder until the encoder angle is equal to the Θ MAX commanded angle, U13B resets the direction flip-flop causing the scanner to sector between the Θ MIN and Θ MAX angles. The Θ MAX angle comparator is inhibited if the sector bit in the command word is set low.

2.18 FAULT DETECTION AND ISOLATION TECHNIQUES

Fault isolation should begin by checking the interface signals on the user interface connector J1. Verify that word gate, command envelope, command data, SMSSS, and the 10 kilohertz clock signal have the proper levels and timing to isolate the problem to the PAS system. The pin assignments for all of the signals on the user interface connector are listed as Table 5. The input power should measure 28 volts $\pm$ 2% and the signal ground, chassis ground, and 28 volt return should be within a fraction of a volt of the spacecraft ground.

Proper operation of the DC power converter can be verified by measuring the input current in various modes of operation and comparing these current levels with the acceptance test data. The status of the internal 20 volt



Command Word Name	Number of Bits	Definition																							
E ₃₇ to E ₂₉	9	Unused Bits																							
E ₂₈ to E ₂₆	3	Spare Bits Stored But Not Used																							
E ₂₅	1	Mode Selector Control E ₂₅ = 0 Spherical Mode E ₂₅ = 1 Planar Mode																							
E ₂₄ to E ₂₃	2	Rate Control MSB is first in LSB is last in	<table><tr><th>E₂₄</th><th>E₂₃</th><th>Clock</th><th>Stepper</th></tr><tr><td>0</td><td>0</td><td>1250 Hz</td><td>78 Hz</td></tr><tr><td>0</td><td>1</td><td>625 Hz</td><td>39 Hz</td></tr><tr><td>1</td><td>0</td><td>312 Hz</td><td>19.5Hz</td></tr><tr><td>1</td><td>1</td><td>156 Hz</td><td>9.75Hz</td></tr></table>	E ₂₄	E ₂₃	Clock	Stepper	0	0	1250 Hz	78 Hz	0	1	625 Hz	39 Hz	1	0	312 Hz	19.5Hz	1	1	156 Hz	9.75Hz		
E ₂₄	E ₂₃	Clock	Stepper																						
0	0	1250 Hz	78 Hz																						
0	1	625 Hz	39 Hz																						
1	0	312 Hz	19.5Hz																						
1	1	156 Hz	9.75Hz																						
E ₂₂	1	Scan Direction Control 0 = CCW, 1 = CW																							
E ₂₁ to E ₁₃	9	Theta Maximum (Θ _{max}) Angle MSB first, LSB last																							
E ₁₂	1	Slew Enable 0 = disabled, 1 = enabled																							
E ₁₁	1	Selector Scan Control 0 = Continuous Submode 1 = Sector Scan between Θ _{max} and Θ _{min} angles																							
E ₁₀	1	Sun Sensor Select Control 0 = PAS Sun Sensor 1 = SMSS Sun Sensor																							
E ₉ to E ₁	9	Theta Minimum (Θ _{min}) Angle MSB first, LSB last																							

Table 3. Serial Digital Command Word Definition



Data Word Name	Number of Bits	Definition
θ_{10} to θ_1	10	<u>Encoder Angle</u> $\theta_{10} = 0$ for CCW $\theta_{10} = 1$ for CW θ_9 to θ_1 are encoder angle with $\theta_9 = \text{MSB}$, $\theta_1 = \text{LSB}$
S_{10} to S_1	10	<u>Status Word</u> S_{10} - Invalid Data if = 1 S_9 - New Data Planar Mode only. S_8 - Target overflow = 1 S_7 - Slew Enable = 1 S_6 - Sector Scan Mode = 1 S_5 - Sun Sensor Select SMSS = 1 S_4 - MSB Rate Control See Table 1 S_3 - LSB Rate Control for Definition S_2 - Scan Direction Control CW = 1 S_1 - Mode Selector Control Planar = 1 Spherical = 0
LOS_{10} to LOS_1	10 (LOS 3)	All six AOS's and LOS's have the same format This format is different in PLANAR and SPHERICAL mode. SPHERICAL MODE: 10 bit binary number representing count (time). $\text{AOS/LOS}_{10} = \text{MSB}$ $\text{AOS/LOS}_1 = \text{LSB}$ PLANAR MODE: Bits AOS/LOS_1 through AOS/LOS_9 are a hybrid GREY/ BINARY code representing encoder position $\text{AOS/LOS}_9 = \text{MSB}$, $\text{AOS/LOS}_1 = \text{LSB}$ AOS/LOS_{10} represents direction of scan: 1 = CW 0 = CCW
AOS_{10} to AOS_1	10 (AOS 3)	
LOS_{10} to LOS_1	10 (LOS 2)	
AOS_{10} to AOS_1	10 (AOS 2)	
LOS_{10} to LOS_1	10 (LOS 1)	
AOS_{10} to AOS_1	10 (AOS 1)	
Total	80	

Table 4. Data Word Definition

USER INTERFACE CONNECTOR

J1: 311P407-4P-B-15 (Amplimate, 62 pin); on PAS Main Electronics

P1: 311P407-4S-B-15 (Amplimate, 62 pin); on User Wire Harness

J1/P1 PIN No.	SIGNAL NAME	J1/P1 PIN No.	SIGNAL NAME	J1/P1 PIN No.	SIGNAL NAME
1	TP 1	22	CHASSIS GND	43	SCAN THMS 1
2	TP 2	23	CHASSIS GND	44	SCAN THMS 1 RTN
3	WORD GATE 1	24	SPARE	45	SCAN THMS 2
4	WORD GATE 2	25	SHIFT PULSE 1	46	SERIAL DATA OUTPUT 1
5	SCAN THMS 2 RET	26	SHIFT PULSE 2	47	SERIAL DATA OUTPUT 2
6	CMD ENV 1	27	SPARE	48	SPARE
7	CMD ENV 2	28	CMD CLK 1	49	CMD DATA 1
8	SPARE	29	CMD CLK 2	50	CMD DATA 2
9	SCANNER OUT 1 (TP)	30	SPARE	51	SPARE
10	SPARE	31	SUN SLIT 1	52	SMSSS 1
11	SPARE	32	SUN SLIT 2	53	SMSSS 2
12	+5V MONITOR	33	SPARE	54	SPARE
13	+20V MONITOR	34	TP 4	55	S/N STRAP 1
14	TP 3	35	TP 5	56	S/N STRAP 2
15	SIG GND	36	TP 6	57	S/N STRAP 3
16	SIG GND	37	TP 7	58	S/N STRAP 4
17	ELECT THMS 1	38	10V SUN PULSE	59	SPARE
18	ELECT THMS 1 RTN	39	ELECT THMS 2	60	SPARE
19	SPARE	40	ELECT THMS 2 RTN	61	10KHz 1
20	+28V DC	41	28V RTN	62	10KHz 2
21	+28V DC	42	28V RTN		

Table 5 USER INTERFACE CONNECTOR



and 5 volt power busses can be determined by comparing the 5 volt monitor and 20 volt monitor test points with levels measured during acceptance test. Failures in the PAS system can be likewise isolated by measuring the signals at the head electronics interface. Table 6 is a listing of these signals. The following power supply levels represent normal operation at ambient temperatures.

<u>Signal Name</u>	<u>Return Name</u>	<u>Voltage Level</u>	<u>Current Level</u>
Heater	Heater return	28 volt $\pm$ 2%	< 3 milliamps
10 volt DC	10 volt DC return	12.6 volts $\pm$ 15%	17 milliamps $\pm$ 20%
5 volt DC	5 volt return	5 volt $\pm$ 10%	10 milliamps $\pm$ 25%

The following signal returns should be within a fraction of a volt of the spacecraft ground. Chassis ground, heater return, 10 volt return, 5 volt return. Proper operation of the motor and encoder can be verified by commanding the PAS to the planar mode and observing the Phase A, B, C, and D motor. The motor drivers should generate a 20 volt pulse sequentially on each of the motor leads at the motor step rate timing. The encoder A, B, C, and D signals should switch between 0 and 10 volt in the grey code sequence corresponding to the stepper motor operation. The HOME signal, should switch to a zero level when the encoder count passes between 0 and 8. The scanner signal should switch from 0 volts to 10 volts when the scanner is illuminated, on axis, with a light intensity greater than 1/10 of a full space moon. The sun slit should switch from 0 volts to 10 volts when the sun slit is illuminated within its FOV with a light level greater than approximately 1/3 of a space sun. All thermistors should measure approximately 10 K ohm at room temperature when measured at either the head electronics interface or at the user interface connector.

HEAD-ELECTRONICS INTERFACE CONNECTORS

J2: 311P407-3S-B-15 (Amplimite, 44 pin); on PAS Main Electronics
P2: 311P407-3P-B-15 (Amplimite, 44 pin); on Head-Electronics Wire Harness
P1: 311P407-3S-B-15 (Amplimite, 44 pin); on Head-Electronics Wire Harness
J1: 311P407-3P-B-15 (Amplimite, 44 pin); on PAS Sensor Head

J2/P2 P1/J1 PIN No.	SIGNAL NAME	J2/P2 P1/J1 PIN No.	SIGNAL NAME	J2/P2 P1/J1 PIN No.	SIGNAL NAME
1	SCANNER ANALOG	16	CHASSIS GND	31	CHASSIS GND
2	HEATER	17	SUN SLIT ANALOG	32	SCAN THERMISTOR 1
3	HEATER	18	HEATER RETURN	33	SCAN THERMISTOR RETURN 1
4	SCAN THERMISTOR 2RTN	19	HEATER RETURN	34	SCAN THERMISTOR 2
5	+10V DC	20	10V RETURN	35	HOME
6	+10V DC	21	10V RETURN	36	HOME
7	SCANNER	22	SUN SLIT	37	SPARE
8	SCANNER	23	SUN SLIT	38	ENCODER C
9	ENCODER A	24	ENCODER B	39	ENCODER C
10	ENCODER A	25	ENCODER B	40	SPARE
11	SPARE	26	SPARE	41	φD MOTOR
12	φA MOTOR	27	φB MOTOR	42	φD MOTOR
13	φA MOTOR	28	φB MOTOR	43	φC MOTOR
14	+5VDC	29	5V RETURN	44	φC MOTOR
15	+5VDC	30	5V RETURN		

Table 6 HEAD ELECTRONICS INTERFACE CONNECTOR



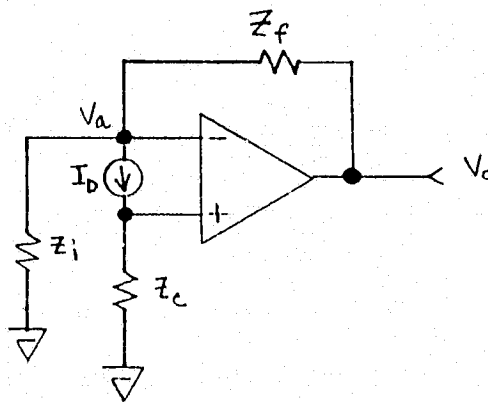


3.0 ANALYSIS OF THE DESIGN

This section contains an analysis of the sun slit and scanner signal paths.

3.1 SUN SLIT BANDWIDTH

The following circuit represents the sun slit amplifier.



$$V_a = I_D (z_i || z_f + z_c) - V_o \frac{z_i}{z_i + z_f} = 0$$

$$V_o \frac{z_i}{z_i + z_f} = \frac{z_i z_f}{z_i + z_f} + z_c I_D$$



$$\begin{aligned} \therefore \frac{V_o}{I_o} &= Z_f + Z_c \frac{Z_i + Z_f}{Z_i} \\ &= Z_f + Z_c \left[1 + \frac{Z_f}{Z_i} \right] \end{aligned}$$

$$\frac{V_o}{I_o} = Z_f + Z_c + \frac{Z_c Z_f}{Z_i}$$

Substituting:

$$Z_c = \frac{R}{1 + sRc} = \frac{R_c}{1 + jf/f_c} \quad f_c = 1/2\pi R_c C_c$$

$$Z_f = \frac{R_f}{1 + jf/ff} \quad ff = 1/2\pi R_f C_f$$

$$Z_i = R_i$$

$$\therefore \frac{V_o}{I_D} = \frac{R_f}{1 + jf/ff} + \frac{R_c}{1 + jf/f_c} + \frac{R_c}{1 + jf/f_c} \frac{\frac{R_f}{1 + jf/ff}}{R_i}$$

Since $f_F = f_c$, let $f_F = f_p$

Then

$$\frac{V_o}{I_D} = \frac{R_f}{1 + jf/f_p} + \frac{R_c}{1 + jf/f_p} + \frac{R_c}{1 + jf/f_p} \frac{R_f}{R_i} \frac{1}{1 + jf/f_p}$$

$$\frac{V_o}{I_D} = \frac{1}{1 + jf/f_p} \left[R_f + R_c + R_c \frac{R_f}{R_i} \frac{1}{1 + jf/f_p} \right]$$



or

$$\frac{V_o}{I_D} = \left[\frac{R_F + R_c}{1 + jf/f_p} + \frac{R_c R_f}{R_i} \frac{1}{(1 + jf/f_p)^2} \right]$$

$$R_F = 5.1(10^6) \quad C_F = 68(10^{-12})$$

$$R_i = 10^9 \quad C_i = 3300(10^{-12})$$

$$R_c = 10^9$$

$$f_F = 455 \text{ Hz} \approx f_c = 482 \text{ Hz} = f_p$$

$$R_i = R_c \text{ and } R_f = R_c$$

$\therefore$

$$\frac{V_o}{I_D} \approx \frac{R_f}{1 + jf/f_p} + R_F \frac{1}{(1 + jf/f_p)^2}$$

$$\frac{V_o}{I_D} \approx \frac{R_f}{1 + jf/f_p} \left[1 + \frac{1}{1 + jf/f_p} \right]$$

Therefore: approximating

$$\frac{V_o}{I_D} \approx \frac{2R_F}{1 + jf/f_p} = \frac{2(5)(10^6)}{1 + jf/455} \approx \frac{10^7}{1 + jf/455}$$

$\therefore$

$$A = \frac{140}{1 + jf/455} \text{ db Closed loop Transimpedance Gain}$$

If $R_f = 8.66\text{M}$ and $C_f = 39\text{pf}$ then:

$$A_I = \frac{R_f}{1 + jf/F_f} + \frac{R_c}{1 + jf/F_c} + \frac{R_c}{1 + f/f_c} \frac{R_f}{R_i} \frac{1}{1 + jf/F_f}$$

$$F_f = 471 \text{ Hz}$$

$$F_c = 482 \text{ Hz}$$

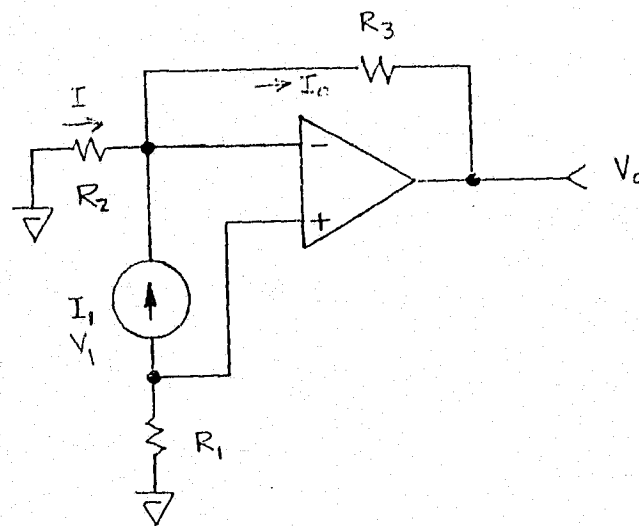


$$\therefore A \cong \frac{2RF}{1 + jF/FP} \cong \frac{2(8.6)(10^6)}{1 + jF(471)} = \frac{17.2(10^6)}{1 + jF/471}$$

$$A \cong \frac{1.7(10^7)}{1 + jf/471}$$

3.2 SUN SLIT VOLTAGE DRIFT

Gain



$$I_{in} = \frac{0 - V_1}{R_1} \quad \text{and} \quad I_o = I_{in} + I$$

$$I_{in} = I_o - I$$

$$I = \frac{0 - V_1}{R_2} \quad \text{and} \quad I_o = \frac{V_1 - V_o}{R_3}$$

$$\therefore I_{in} = \frac{V_1 - V_o}{R_3} + \frac{V_1}{R_2}$$

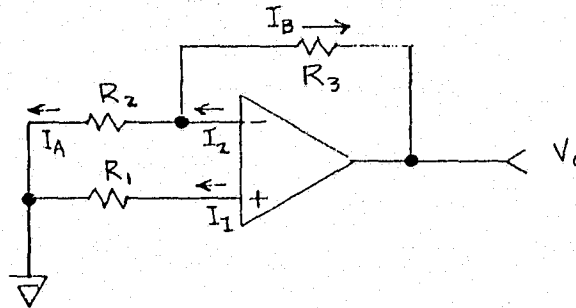
$$\text{but } V_1 = -I_{in}R_1$$

$$I_{in} = \frac{-I_{in}R_1 - V_o}{R_3} - I_{in}\frac{R_1}{R_2}$$



$$\begin{aligned}\frac{V_o}{I_{in}} &= -R_3 \left(1 + \frac{R_1}{R_3} + \frac{R_1}{R_2}\right) = -(R_1 + R_3 + R_3 \frac{R_1}{R_2}) \\ &= -R_1 + R_3 \left(1 + \frac{R_1}{R_2}\right)\end{aligned}$$

Current Drift



$$V_1 = I_1 R_1$$

and

$$I_2 = I_A + I_B \quad \text{when } I_A = \frac{V_1}{R_2} \quad I_B = \frac{V_1 - V_o}{R_3}$$

$$I_2 = \frac{V_1}{R_2} + \frac{V_1 - V_o}{R_3}$$

$$\frac{I_1 R_1}{R_2} + \frac{I_1 R_1 - V_o}{R_3} = I_1 \left(\frac{R_1}{R_2} + \frac{R_1}{R_3} \right) - \frac{V_o}{R_3}$$



$$V_o = + R_1 R_3 I_1 \left(\frac{1}{R_2} + \frac{1}{R_3} \right) - I_2 R_3$$

$$= R_1 I_1 (1 + A) - I_2 R_3$$

now

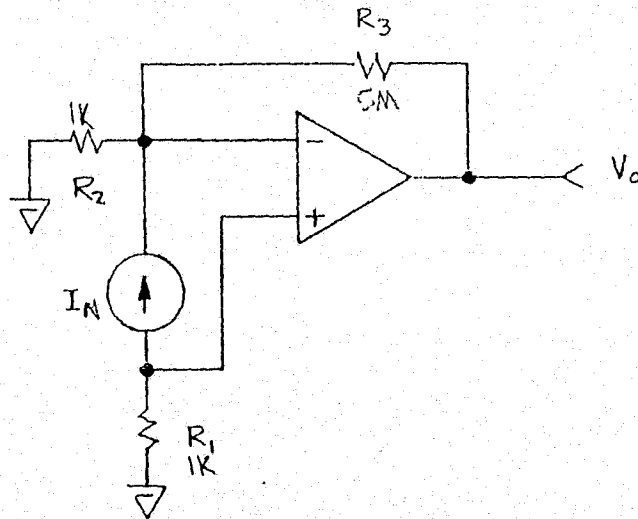
$$I_{OS} = I_2 - I_1 \text{ and } I_2 = I_{OS} + I_1$$

$$V_o = I_1 \left[R_1 (1 + A) - R_3 \right] - I_{OS} R_3$$

minimize above, then:

$$R_1 (1 + A) = R_3 \quad \text{where } A = \frac{R_3}{R_2}$$

$$\therefore R_1 = \frac{R_3 R_2}{R_3 + R_2}$$



Gain

$$\frac{V_o}{I_{in}} = R_1 + R_3 + \frac{R_1 R_3}{R_2} = R_1 + R_3 \left(1 + \frac{R_1}{R_2} \right)$$

$$\text{with } R_1 = R_2$$

$$\frac{V_o}{I_{in}} = 2R_3$$

Current Drift.

$$I_1 - I_2 = \frac{V_o}{R_3} \left[1 - \frac{1}{1 + \frac{R_3}{R_2}} \right] = \frac{V_o}{R_3} \frac{R_3}{R_2 + R_3}$$

$$\therefore V_o = (I_1 - I_2) (R_2 + R_3)$$



Using LM108A data

$$V = 5\mu \text{ V/oC}$$

$$I = 2.5\text{pA/oC}$$

$$\begin{aligned}\text{Voltage Drift} &= 5 \times 10^{-6} \times 85 \left(1 + \frac{5.1 \times 10^6}{10^5}\right) \\ &= \underline{\underline{22.1 \text{ mv}}}\end{aligned}$$

$$\begin{aligned}\text{Current Drift} &= 2.5 \times 10^{-12} \times 85 \times 5.2 \times 10^6 \\ &= \underline{\underline{1.1 \text{ mv}}}\end{aligned}$$

3.3 SCANNER BANDWIDTH

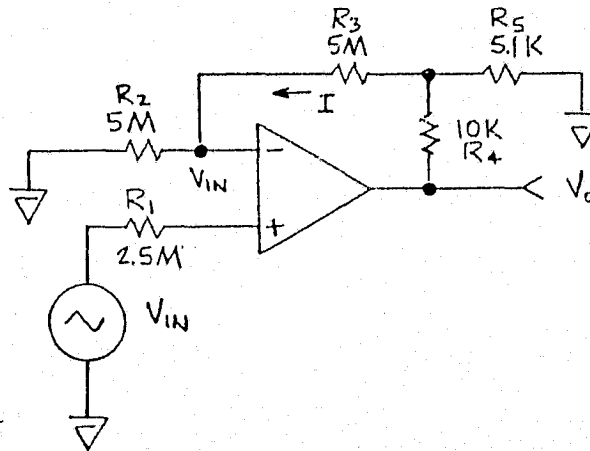
The scanner bandwidth is controlled by a single pole in the second stage.

$$f_p = \frac{1}{2\pi RC} = \frac{1}{2\pi(620 \times 10^3)(330 \times 10^{-12})}$$

$$f_p = 780 \text{ Hz.}$$



3.4 SCANNER VOLTAGE DRIFT



$$V_2 = V_o \frac{R_5}{R_4 + R_5}$$

$$I = \frac{V_{in}}{R_2} = \frac{V_2 - V_{in}}{R_3}$$

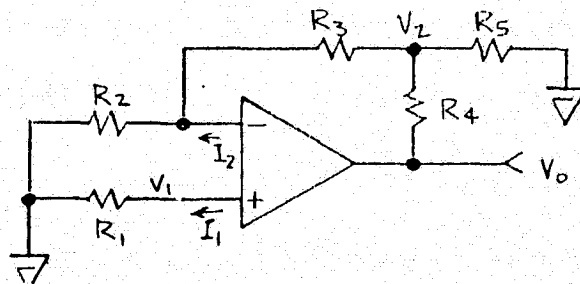
$$\frac{V_{in}}{R_2} = \frac{V_o R_5}{R_3 (R_4 + R_5)} - \frac{V_{in}}{R_3}$$

$$V_{in} \left(\frac{1}{R_2} + \frac{1}{R_3} \right) = V_o \frac{R_5}{R_3 (R_4 + R_5)}$$

$$A = \frac{V_o}{V_{in}} = \left| \frac{R_2 + R_3}{R_2 R_3} \right| \left| \frac{R_3 (R_4 + R_5)}{R_5} \right|$$

$$V_o = \pm V_{in} \frac{R_4 + R_5 + \frac{R_3}{R_2} (R_4 + R_5)}{R_5}$$

Current Drift





$$V_1 = I_1 R_1$$

$$I_2 = \frac{V_1}{R_2} + \frac{V_1 - V_2}{R_3}$$

$$\text{and } V_2 = V_0 \frac{R_5}{R_4 + R_5}$$

$$I_2 = \frac{I_1 R_1}{R_2} + I_1 \frac{R_1}{R_3} - V_0 \left(\frac{R_5}{R_4 + R_5} \right) \frac{1}{R_3}$$

$$- \frac{V_0}{R_3} \frac{R_5}{R_4 + R_5} = I_2 - I_1 R_1 \frac{1}{R_2} + \frac{1}{R_3}$$

$$V_0 = - I_2 R_3 \frac{R_4 + R_5}{R_5} + I_1 R_1 \frac{R_4 + R_5}{R_5} (1 + A)$$

$$\text{now } I_2 = I_{os} + I_1$$

$$V_0 = - (I_{os} + I_1) R_3 \frac{R_4 + R_5}{R_5} + I_1 R_1 \frac{R_4 + R_5}{R_5} (1 + A)$$

$$= - I_{os} R_3 \frac{R_4 + R_5}{R_5} + I_1 R_1 \frac{R_4 + R_5}{R_5} (1 + A) R_1 - R_3$$

since $I_1 \gg I_{os}$ minimize above

$$R_1 = \frac{R_3 R_2}{R_3 + R_2}$$



Voltage and Current Drift Calculations

LM108A

$$V_{ov} = 5\mu\text{V}/^{\circ}\text{C} \text{ (max)}$$

$$I_{oc} = 2.5\text{pA}/^{\circ}\text{C} \text{ (max)}$$

Using -25°C to $+60^{\circ}\text{C}$ Range

$$V_{ot} = 85^{\circ}\text{C} \times 5 \times 10^{-6} \times 5.92 = \pm 2.52\text{MV}$$

and

$$V_{oc} = \pm \Delta I R_3 \times 85^{\circ}\text{C} \frac{R_4 + R_5}{R_4} = \pm 3.2 \text{ MV}$$

Voltage and Current Drift for First Stage

$$V_t = \sqrt{(2.52)^2 + (3.2)^2} \times 10^{-3} = 4.1 \text{ MV}$$

For second stage:

$$V_{ot} = \frac{5 \times 10^{-6}}{^{\circ}\text{C}} \times 85^{\circ}\text{C} \times 310 = 131 \text{ mV}$$

$$V_{oc} = \frac{2.5 \times 10^{-12}}{^{\circ}\text{C}} \times 85^{\circ}\text{C} \times 620 \times 10^3 = 0.13 \text{ mV}$$

Total system drifts, worst case

$$V_{ot}^2 = [(131)^2 + (0.13)^2 + (310 \times 4.1)^2] (10^{-3})^2$$

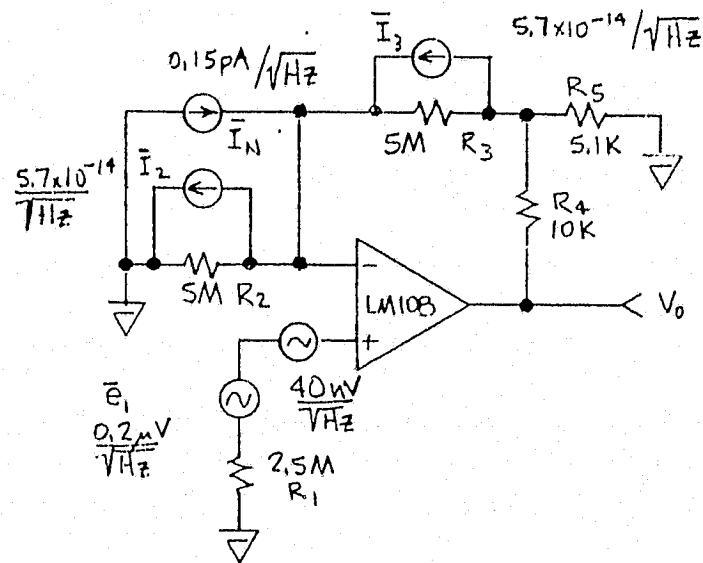
$$= \pm 1.28\text{v}$$

using typical values

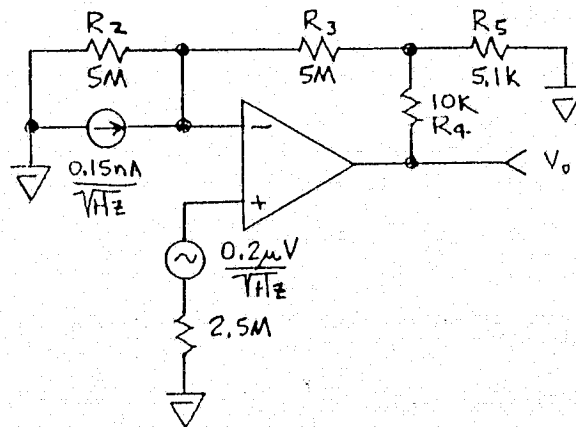
$$V_{ot} = \pm 255 \text{ mV}$$



3.5 SCANNER NOISE



The noise current contribution of R_4 and R_5 is negligible. Therefore, above reduces to that shown below:



I_{eq} due to the noise voltage is:

$$V_0 = 0.2 \times 10^{-6} \times A / \sqrt{\text{Hz}}$$

$$\text{where } A = \frac{R_4 + R_5 + \frac{R_3}{R_2} (R_4 + R_5)}{R_5} = 5.92$$

$$V_0 = 0.2 \times 10^{-6} \times 5.92 = 1.18 \mu\text{V} / \sqrt{\text{Hz}}$$



NOISE CALCULATIONS:

$$\sqrt{4KT} = \sqrt{1.65 \times 10^{-20}}$$

$$\frac{I}{\sqrt{\text{Hz}}} = \sqrt{\frac{4Kt}{R}} \quad \text{and} \quad \frac{e}{\sqrt{\text{Hz}}} = \sqrt{4KTR}$$

$$\bar{e}_1 = \frac{0.2 \mu\text{V}}{\sqrt{\text{Hz}}}$$

$$\bar{I}_2 = I_3 = \frac{5.7 \times 10^{-14} \text{ A}}{\sqrt{\text{Hz}}}$$

$$R_S = 0$$

$$\bar{e}_N = \frac{40 \text{ nV}}{\sqrt{\text{Hz}}}$$

$$R_S = 1 \times 10^6$$

$$\text{and } \bar{I}_R = \frac{0.13 \text{ pA}}{\sqrt{\text{Hz}}}$$

$$V_{ot} = \sqrt{(\bar{I}_R R_S)^2 + (\bar{I}_N R_S)^2 + \bar{e}_N^2}$$

$$V_{ot}^2 - \frac{(\bar{I}_R R_S)^2 - \bar{e}_N^2}{R_S^2} = \bar{I}_N^2$$

$$\bar{I}_N^2 = \frac{(200 \times 10^{-9})^2 - (0.13 \times 10^{-12} \times 10^6)^2 - (40 \times 10^{-4})^2}{(10^6)^2}$$

$$\bar{I}_N = \frac{0.15 \text{ pA}}{\text{Hz}}$$



I_{eq} due to V_o is:

$$I_{eq} = \frac{1.18 \times 10^{-6}}{2.96 \times 5.1 \times 10^6} = 7.8 \times 10^{-14}$$

Therefore:

$$\overline{I_T}^2 = [(0.078)^2 + (0.15)^2 + (0.057)^2 + (0.057)^2] \times (10^{-12})^2$$

$$\overline{I_T} = 0.17 \text{ pA/ } \sqrt{\text{Hz}}$$

The equivalent noise current for 780 Hz bandwidth is:

$$\overline{I_{eq}} = \frac{0.17 \times 10^{-12}}{\sqrt{\text{Hz}}} \cdot \sqrt{780 \times 1.57} = 5.95 \text{ pA}$$



4.0 TECHNICAL SUMMARY

This section summarized the design considerations and design approach of the PAS from a system standpoint.

4.1 SENSOR SYSTEM

The IUE-PAS is a medium accuracy solid state attitude determining system consisting of two separate sensors, the sun slit and the scanner. The electronics assembly has two basic modes with two submodes each. These are the spherical and the planar modes with the submodes being the continuous and sector scan. The PAS operation is controlled by a 37 bit serial digital command word. The output data is then read out in an 80 bit serial digital word and two single discrete digital pulses to represent the sun crossing. The 80 bit serial word contains timing or angle information about the Sun, Earth and Moon crossing the respective fields of view.

The PAS hardware consists of a sun slit sensor, scanner sensor and associated electronics. The sun slit sensor uses the collimated sun signal with a slit aperture to provide signal to a photo diode (silicon) detector. The scanner consists of a light shield, optics assembly, scanner drive mechanism and encoder. The associated electronics consists of command decoders, logic control, counters, driver control, registers and power converter. A simplified functional block diagram is shown in



Figure 13. As light comes into the system from either spin of the spacecraft or because of the scanner drive it is encoded either in time from sun crossing or angle of encoder depending on the mode of operation (spherical or planar). The data is shifted out in an 80 bit word upon command from the spacecraft.

4.2 MECHANICAL

The electronics is located in both the sensor head and the electronics assembly. However, the only parts located in the head are the preamp's, heater control and part of the encoder electronics. The electronics assembly contain the bulk of the electronics including the power converter.

The mechanical assembly is also in two parts the scanner head and the electronics. The head assembly is the more complex since there is a scanning mechanism used to provide signals. The scanner head mechanism consists of a 45 degree stepper motor that drives a 64 to 1 gear train. The gear train is four passes of 4 to 1 gear reduction. The final gear is an antibacklash to take out angular variations. The optical assembly is then driven at variable rate depending on the mode and command status from 78 Hz down to one each digital word gate. (For the very slow DWG condition).

The mounting of the scanner head is provided at four position pads. The four pads will define one plane to within 0.1 degrees and mates with a similar surface on the spacecraft. The electronics assembly will also be mounted by four pads if it is the unit that ends up on the bottom in the spacecraft. The electronics unit is also provided with four through holes in the corners of the box to allow them to be stacked in the spacecraft.

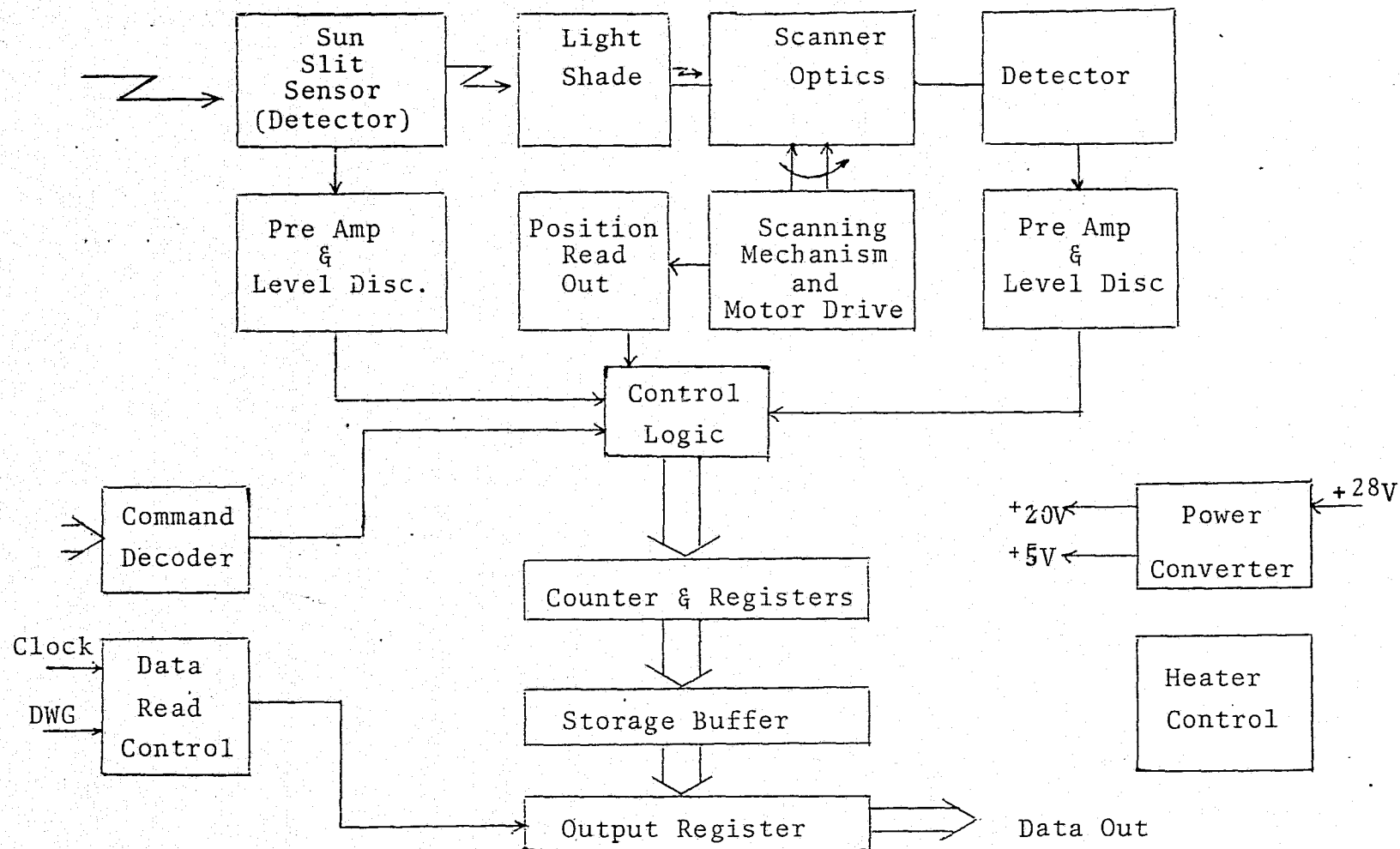


Figure 13 Simplified Block Diagram



4.3 SYSTEM DESCRIPTION

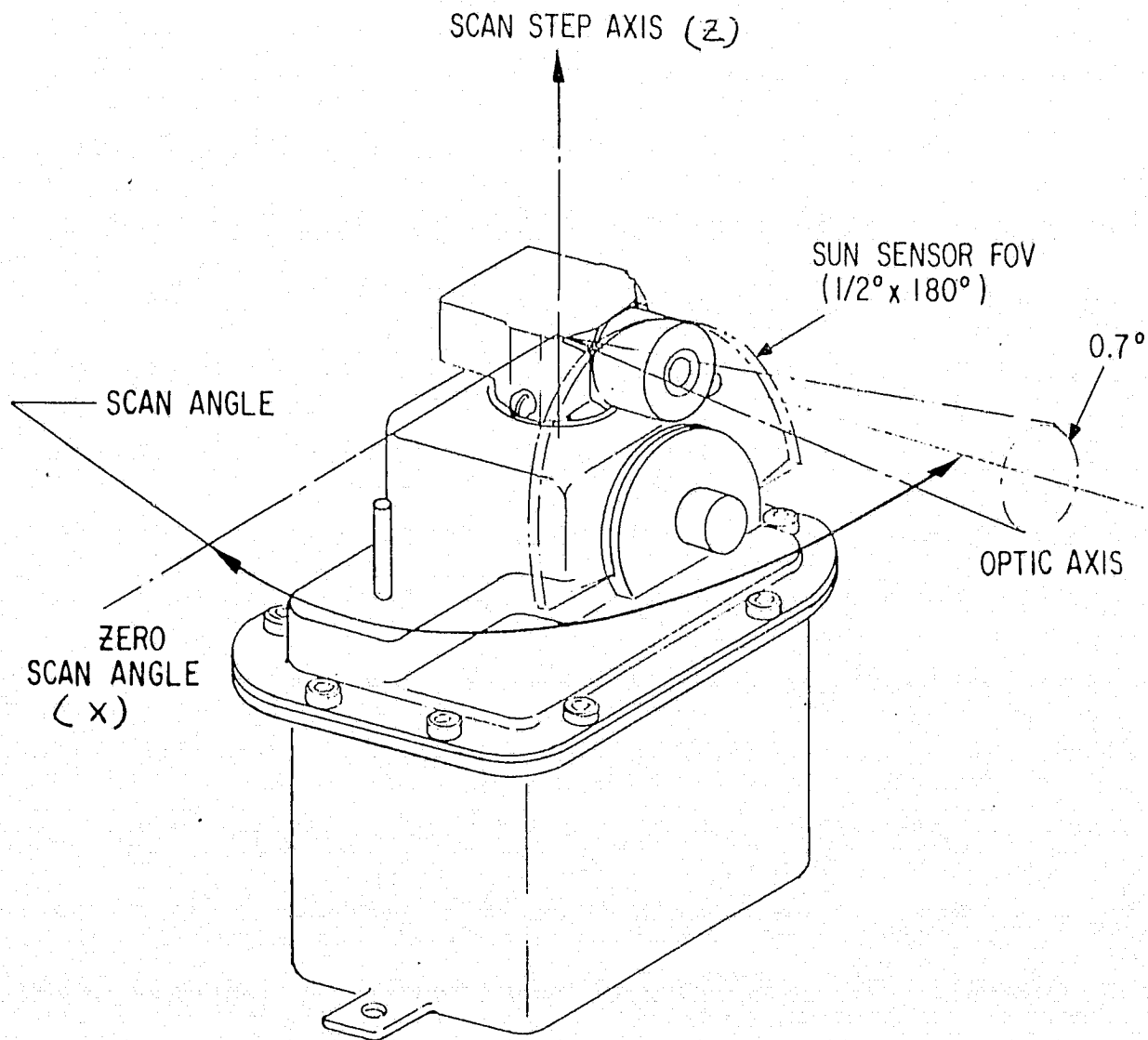
The sensor is a two mode operational aspect sensing system. The two modes are spherical and planar. Each of the two modes have two submodes which are the continuous and sector scan. The objective is to detect a crossing of the sensor field of view by either the Sun, Earth limb or Moon and encode data sufficient to determine the spacecraft attitude. This is accomplished by either measuring the crossing times relative to the Sun crossing (spherical) or the angle relative to a set of body fixed coordinates (planar mode). The resolution of this sensor is 0.7 degrees in all modes.

The sensor operation is controlled by a serial digital command word. The output is also serial digital data which can be read out at variable rates depending on the frequency of word-gate commands and read out clock.

The sensor consists of a solid state silicon 0.5° by 180° sun slit sensor and a 0.7° by 360° scanner angle sensor. The sun sensor has a fixed field of view and is activated at each sun crossing of the 180° by $.5^\circ$ fan shaped field of view. The scanner is a 0.7° field of view sensor which can be positioned by a stepper motor to 512 positions, of about $.7^\circ$ each.

4.4 Spherical Mode

The spherical mode is for the spinning spacecraft condition. The maximum spin rate is 60 RPM about the x-axis defined in Figure 14. as the unit is spun about the sun slit crossing is used to start a counter. When the Sun, Earth and Moon crosses the scanner field of view two times are stored in AOS,



Instrument Assembly
(Scanner Head)

Figure 14



(Acquisition of Signal) and LOS (Loss of Signal) holding registers. The registers are clocked counters that start counting on a sun crossing and stop on a AOS or LOS. The steering logic then will accept the next AOS or LOS into two more counter/registers. The unit is designed to hold up to three sets of AOS, LOS pairs. If for example, only one of the two pairs of AOS/LOS signals are encountered in any one sun to sun crossing time the third AOS LOS position will contain the spin period. The data is then transferred to the storage buffer A after one sun crossing to sun crossing and held there until a digital word gate comes along. At this time (DWG) the next sun crossing dumps data into storage buffer B while A was read out at (DWG). This operation sequence is independent of the submode status.

The submodes are continuous and sector scanned. The continuous submode is where depending on the commanded stepper direction, the scanner is advanced one step on the first sun crossing after a DWG. This then permits the complete map of the sky in 256 spin periods or DWG's whichever is the longer time. The intent here is to permit operation with many DWG's per spin period as well as many spin periods per DWG with no circuit modification.

The second submode of spherical is the sector scan. The scanner in this mode steps one step on the first sun crossing after DWG as before except now only between θ max. and θ min. (θ max. and θ min. are commanded through the command words.) The direction of scan controls the selected scan between θ max. to θ min or θ min. to θ max. (inside or outside angles).

The scanner will continue to scan between θ max. and θ min.



until switched to another mode or submode. The data is transferred the same as before (continuous submode).

There is one condition which is unique to the sector mode and that is where θ max. equals θ min. When this condition is commanded, the scanner will step as before until θ min. at which time the scanner is stopped. The data will still come down as before but the position of the scanner will remain fixed.

4.5 PLANAR MODE

The planar mode is for use with a stabilized spacecraft condition. In this mode the sun sensor is not used. The only data will then be the position of the scanner relative to body fixed position. In this mode up to three AOS/LOS pairs can be recorded per rotation of the scanner. The data is transferred to buffer A or B on the first position θ min. crossing along after a DWG. In this mode the scanner head can be stepped at different rates upon command of 78, 39, 19.5, and 9.75 steps/sec. The data will then be the angular position (0.7° steps) of the AOS/LOS's from θ min. to θ min. There are two submodes in the planar mode as there were in the spherical mode. These are continuous and sector scan. The continuous mode is where the scanner steps at the commanded rate and transfers data on first θ min. crossing after DWG.

The sector submode is where the scanner steps at the commanded rate between θ max. and θ min. The data is transferred on the first θ min. position after DWG. If θ max. is set equal to θ min, this mode will not transmit useful data.



4.6 IUE PAS CONTROL LOGIC

The data flow control is best described with the use of a state diagram shown in Figure 12. The three states are counting, invalid and full. Since we have two output registers, this is a mirror image state for the other register. However the readout register is unique to only one set of three states.

When the power is applied or a command in is received, the unit is in the invalid state. This means that data is to be questionable until a completed spin period. In the invalid state DWG's will not cause the state to change. The only way to get out is with a valid sun crossing. At which time the state changes to full. It should be noted that at all times the counters are counting.

In the full state the output buffers are ready to be readout and only a DWG will cause a state change. For example, a sun crossing will not change the state. Once a DWG comes along, the data in the output buffer is readout and the state changes to counting.

While in the counting state, only a sun crossing or a command in will change the state. A command in initializes the sequence to the invalid state and starts over. A sun crossing loads buffers and transfers state to full and waits for the next DWG.

The mirror image is only to indicate that we are using both buffer register and output register for the same function. They just flip-flop on each set of complete (new) data. This allows us to not miss any valid set of data.

The above description is for the spherical mode but is identical for the planar if we replace sun crossing with θ min. crossing and counting with encoder angle.



5.0 FINAL CALIBRATION DATA

The calibration data in this section comes from the test data taken during the acceptance test of each unit. The test procedures are defined in the documents referenced on each data sheet. The data sheet are in the appendices listed below:

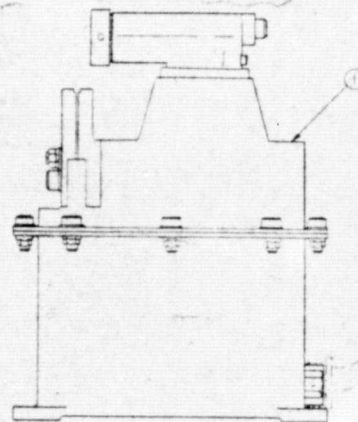
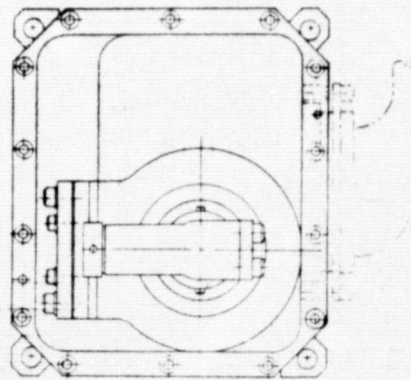
<u>APPENDIX</u>	<u>CALIBRATION DATA</u>	<u>REFERENCE DOCUMENT</u>
C	Power Supply Frequency	BBRC 49960
D	Sun Stability	BBRC 51975
E	Mechanical Dimensions	BBRC 49961
F	Optical and Electrical	BBRC 59959



APPENDIX A

SCHEMATICS

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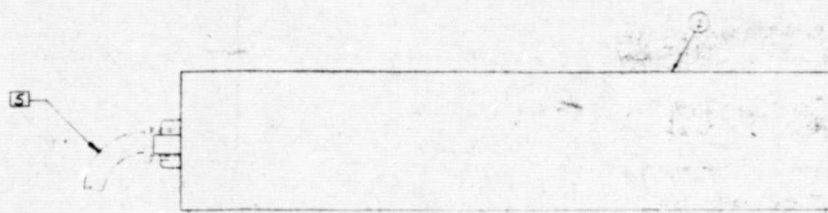
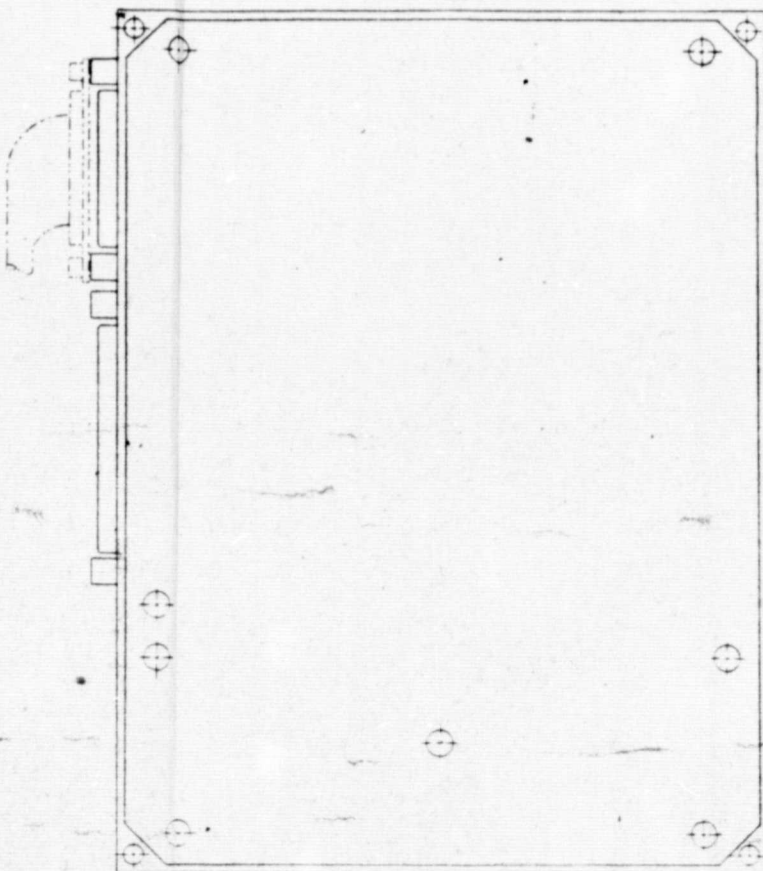
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- NOTES, UNLESS OTHERWISE SPECIFIED:
1. MAX ASSY 48000-1
2. HANDLE PER P21217
3. SHIP ASSY USING 3A
4. PACKAGE PER BPS 9.0
IN ABOVE CONTAINER
5. CABLE IS CUSTOMER



REDUCED SIZE
DUPLICATE
NO REVISIONS TO BE
MADE TO THIS SHEET

REDUCED SIZE
DRAWING

APPROVED	DATE
W. L. H.	7/11
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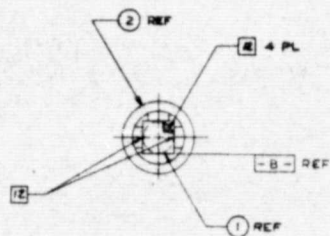
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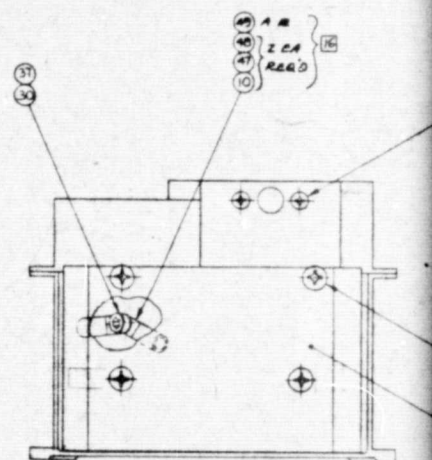
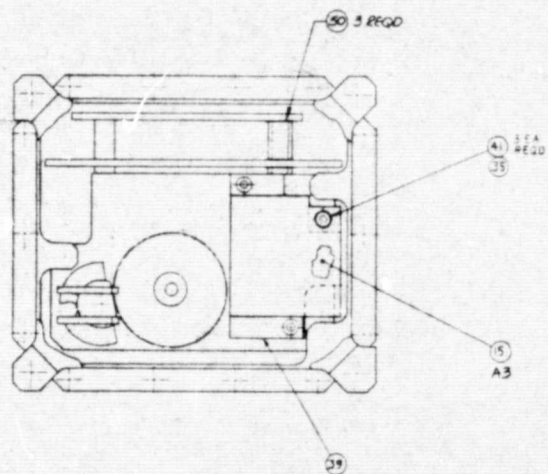
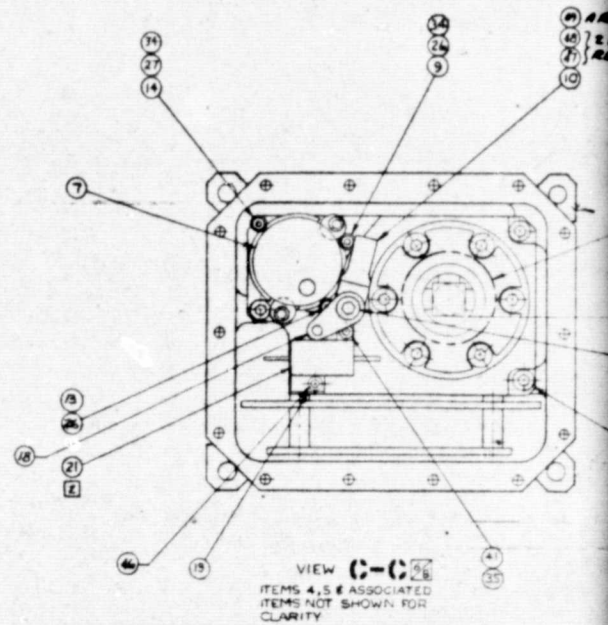
WIRE LIST					ITEM	FUNCTION
CONNECTION	FROM	THRU	TO	CABLE NO.		
J1-1	9	A2 E6	5		42	SCANNER ANALOG
J1-2	NR1-1	5				HEATER PWR (1)
J1-3	NR1-1	7				HEATER PWR (2)
J1-4	RT2-2	9				SCAN THMS (2) RTN
J1-5	19	A1 E14	15			+IOV DC (1)
J1-6	21	A1 E15	16			+IOV DC (2)
J1-7	27	A1 E25	21			SCANNER (1)
J1-8	29	A1 E26	22			SCANNER (2)
J1-9	35	A1 E32	23			ENCODER A (1)
J1-10	40	A1 E35	26			ENCODER A (2)
J1-11						NC
J1-12	40	A1 E37	35			2 A MOT (1)
J1-13	41	A1 E37	34			2 A MOT (2)
J1-14	49	A1 E40	39			+SV DC (1)
J1-15	59	A1 E40	40			+SV DC (2)
J1-16		E1				CHASSIS GND (1)
J1-17	10	A2 E9	4			SUN SLIT ANALOG
J1-18	16	A1 E11	11			HEATER RTN (1)
J1-19	18	A1 E12	12			HEATER RTN (2)
J1-20	15	A1 E2	15			IOV RTN (1)
J1-21	17	A1 E2	14			IOV RTN (2)
J1-22	37	A1 E33	24			SUNSLIT (1)
J1-23	42	A1 E34	25			SUNSLIT (2)
J1-24	45	A1 E44	27			ENCODER B (1)
J1-25	53	A1 E47	28			ENCODER B (2)
J1-26						NC
J1-27	50	A1 E58	31			2 B MOT (1)
J1-28	55	A1 E58	32			2 B MOT (2)
J1-29	52	A1 E55	37			SV RTN (1)
J1-30	58	A1 E55	38			SV RTN (2)
J1-31		E1	2			CHASSIS GND (2)
J1-32	RT1-2	6				SCAN THMS (1)
J1-33	RT1-1	3				SCAN THMS (1) RTN
J1-34	RT1-1	10				SCAN THMS (2)
J1-35	24	A1 E21	17			HOME (1)
J1-36	25	A1 E22	18			HOME (2)
J1-37						NC
J1-38	24	A1 E20	19			ENCODER C (1)
J1-39	28	A1 E23	20			ENCODER C (2)
J1-40						NC

WIRE LIST					ITEM	FUNCTION
CONNECTION	FROM	THRU	TO	CABLE NO.		
J1-41	41	A1 E60	29		42	2 D MOT (1)
J1-42	44	A1 E60	30			2 D MOT (2)
J1-43	51	A1 E59	35			2 C MOT (1)
J1-44	56	A1 E59	36			2 C MOT (2)
A1 E1	11	A2 E1			22	GND
A1 E3	1	A6 E4			22	IOV RTN (IMPROPER CONNECTION)
A1 E5	2	NC				
A1 E6	3	A5 E2			22	GND
A1 E1	5	A8 E1				GND
A1 E1	6	A3 E4				GND
A1 E9	12	A2 E2				+SV DC
A1 E10	17	A3 E3				+SV DC
A1 E13	4	NR1-2				HEATER
A1 E16	3	A3 E1				+IOV RES
A1 E17	14	A2 E3				+IOV RES
A1 E18	20	RT2-2				THMS
A1 E19	33	RT2-1			22	THMS
A1 E24	38	NR1-1				HEATER
A1 E27	25	A2 E4			22	SCANNER AMPL
A1 E28	43	A5 E1				
A1 E29	32	A6 E3				
A1 E30	45	A2 E10				
A1 E31	44	A6 E1				
A1 E36	43	A7 E2				
A1 E39	44	A7 E1				
A1 E38	45	A7 E4				
A1 E39	46	A4 E2				
A1 E40	54	A7 E1				
A1 E48	62	A4 E1				
A1 E54	47	A6 E2				
A2 E5	27	A3 E2				
A2 E7	30	A5-3				
A2 E8	31	A5-2			22	
M1-54		A1 E57				2 A MOT
M1-52		A1 E58				2 B MOT
M1-53		A1 E59				2 C MOT
M1-51		A1 E60				2 D MOT

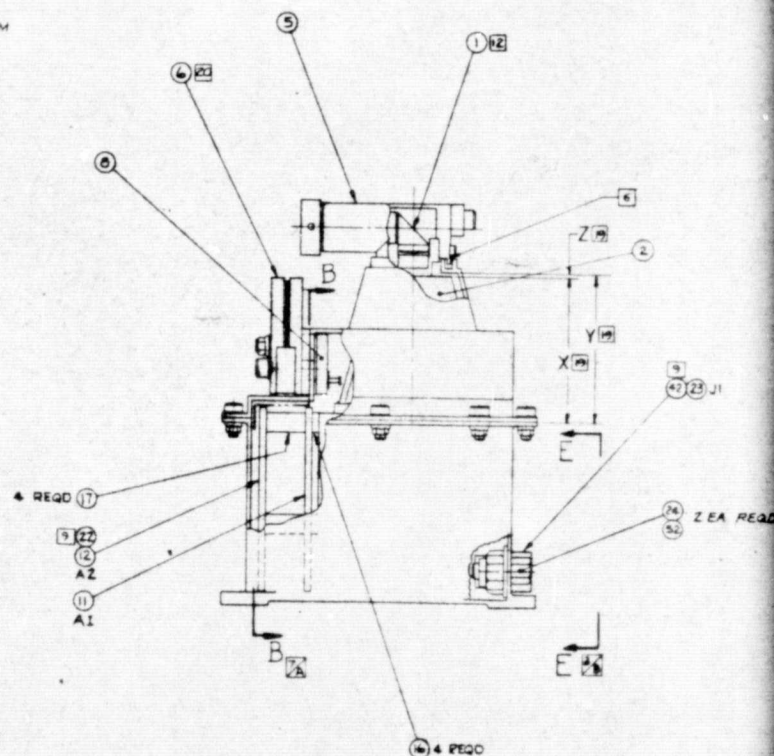
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DUPLICATION
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NOTE: (CONT'D)

9. ETON THERMADIE ENDS PRIOR TO BONDING TO BOARDS. PART 46834.

10. BOND WIRE TO BOARDS PER BPS1108.

11. WIRE SHALL BE 26 AWG, SILVER PLATED COPPER CONDUCTOR, 19 STRAND, 1/16" WIRE TEE "JACKS" PER MIL-W-16878/4 TYPE E.

12. PROCEDURE FOR BONDING ITEM 2 LENS ASSY

- REF. 46002 DRIVE ASSY
- MARK THE 412014 A VERTICAL LOCATION ON THE 46031-1 ANTIBACKLASH GEAR IN THE 46011-1 SHIRT ASSY.
- ALIGN THE SCREWS IN THE 46011-1 CLAMP 6 REMOTE THE SHIRT ASSY.
- SQUARE THE GAP BETWEEN THE LENS ASSY AND THE SHIRT OF THE SHIRT ASSY. RECD. 46002 INDICATED PER BPS1108 AND REMOUNT IN SYSTEM.

2) TORQUE TO 5.5 TO 6.5 IN. LB.

8 MARK AS SHOWN PER BPS 19 00-4-12, CENTERED
APPROX ON CONNECTOR CUTOUT.

MAR 10 1977

.1248 DIA
.1250 DIA
X DEPTH SHOWN

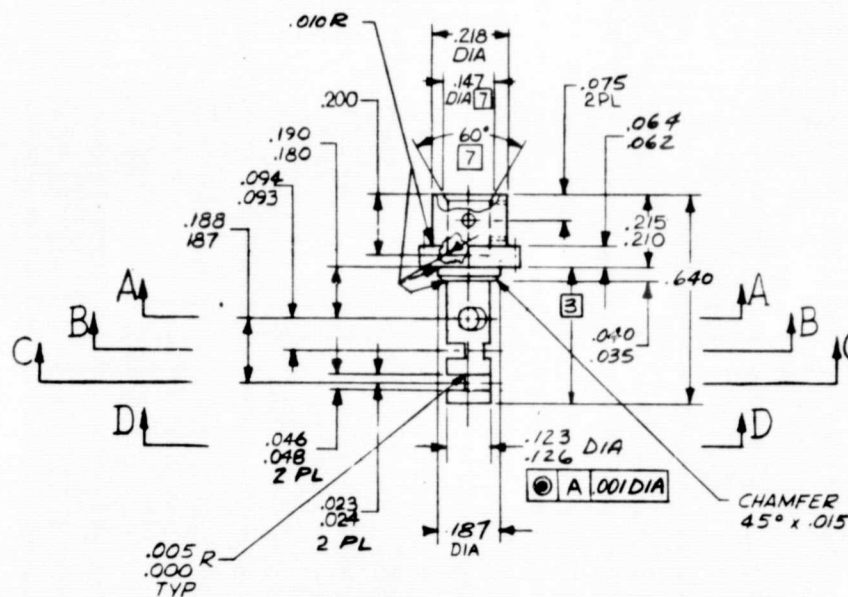
-A-



2-56 UNC-3B THRU
ONE WALL

.025 DIA THRU ONE WALL
.029

MAX PD .2667
DP 120
32 TEETH
AGMA CLASS Q14
20° PRESSURE ANGLE
TOTAL COMPOSITE ERROR .00027
RELATIVE TO DATUM A
GEAR TOOTH PROPORTIONS
PER USAS B4.7
FINISH ON TOOTH WORKING
SURFACE 16/



VIEW E-E
SCALE 10/1

SECTION A-A
SCALE 10/1

VIEW D-D
SCALE 10/1

SECTION B-B
SCALE 10/1

SECTION C-C
SCALE 10/1

FOLDOUT FRAME \

NOTES UNLESS OTHERWISE SPECIFIED
1 MARK 48027-1 PER BPS 19.00-10

2 FINISH: PASSIVATE PER QQ-P-35, TYPE II

3 FINISH INDICATED SURFACE PER MIL-C-13924 CLASS 4 EXCEPT PARA 3.9 AND 3.11.
OMIT FINISH ON GEAR SIDE SURFACE.

4 ENGRAVE .005/.015 WIDE x .003/.006 DEEP AFTER BLACK OXIDE FINISH. DO NOT FILL LINE

5 LUBE GEAR TEETH PER 23561; OVERSPRAY ON SIDES OF GEAR IS PERMISSIBLE. LUBE TO BE DONE BY BBRC.

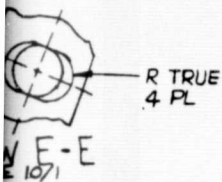
6 HANDLE LUBRICATED GEAR PER P21217

7 INDICATED DIAMETER AND ANGLE OPTIONAL

8 VENDOR TO SUPPLY A TAPE SHOWING THE TOTAL COMPOSITE ERROR (TCE) FOR EACH GEAR

REVISIONS			
DATE	DESCRIPTION	DATE	APPROVED
3/15/75	INITIAL ISSUE	3/15/75	J. L. Hynes
5/15/75	ISSUE # 2	5/15/75	J. L. Hynes
7/7/75	ISSUE # 3	7/7/75	"
10-1-75	A ENGINEERING RELEASED	10-1-75	P.B.

FILE
ERROR .00027
A
ORTIONS
WORKING



.062 DIA
.065 DIA
= A.001 TOTAL

15° 30'
16° 30'
2 PL

REDUCED SIZE
DRAWING

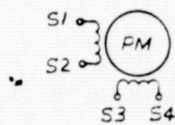
48027 A

APPROVED		DATE	CONTRACT NO. 114-5-20651		APPROVED		DATE	Ball Brothers Research Corporation	
RELIABILITY			UNLESS OTHERWISE SPECIFIED		DESIGNER			Boulder Colorado 80302	
DIMENSIONS			DIMENSIONS ARE IN INCHES.		GROUP ENG.			GEAR, PINION -	
STRESS			TOLERANCES: .001 .010 .015		CHECKED			ENCODER P1	
WEIGHTS			BREAK SHARP EDGES		BALL PRO			48027	
SIZE			MIL STD 12.15		LUBRIC Y32.16, 946.1, Y14.8			D 13993	
MATERIAL			SHOP STANDARDS 2500		THREADS PER INCH			48027	
AA			SURFACE FINISH 1.0		CHECKED AS NOTED			48027	
APPLICATION			LAYOUT NO 5K47799					48027	

FOLDOUT FRAME 2

RELEASED 196725

IS
Y


$$\begin{array}{l} S1 - S2 \\ S3 - S4 \\ S2 - S1 \\ S4 - S3 \end{array}$$

REDUCED SIZE

1000

1. 1990年12月，中共中央、国务院作出《关于实行“以公有制为主体、多种所有制经济共同发展”的方针》，明确非公有制经济是我国社会主义市场经济的重要组成部分。

FOLDOUT FRAME

NOTES UNLESS OTHERWISE SPECIFIED

- 1 MARK 48035, APPLICABLE DATA NO. 1 SERIAL NO. PER BPS1900-10
- 2 ONLY THE ITEM DESCRIBED ON THIS DRAWING WHEN PROCURED FROM THE VENDOR(S) LISTED HEREON IS APPROVED BY THE BALL BROTHERS RESEARCH CORP., BOULDER, COLO., FOR USE IN THE APPLICATION SPECIFIED HEREON. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY THE BALL BROTHERS RESEARCH CORP.

APPROVED SOURCE(S) OF SUPPLY		
VENDOR	VENDORS ITEM IDENT NO.	APPLICATION
IMC	008-890	SE026A (FOR -1)
MAGNETICS CORP	008-890-1	SE 026A (FOR -501)
MAYWOOD, CALIF		
CODE IDENT 53743		

ORIGINAL PAGE IS
OF POOR QUALITY

- 3 ELECTRICAL AND MECHANICAL CHARACTERISTICS SHALL BE IN ACCORDANCE WITH BBRC DESIGN SPECIFICATION 48036
- 4 MOTOR CASE STAINLESS STEEL
- 5 IDENTIFY LEADS, PER SCHEMATIC, WITH TEMPORARY TAGS
- 6 HANDLE PER P21217
- 7 BEARINGS SUPPLIED BY BBRC PER 48036
- 8 RADIAL PLAY-.0008 MAX WITH 8 OZ REV. LOAD, MEASURED AT -B-
END PLAY-.003 MAX WITH 8 OZ REV. LOAD, MEASURED AT -B-
- 9 THE MOTOR SHAFT SHALL ROTATE COUNTER CLOCKWISE (LOOKING AT SHAFT END) WHEN PHASED IN THE INDICATED SEQUENCE

LEADS 28 GA x 24.0 MIN
RAD EXIT HOLE CLOCKING
INCIDENT WITH MOUNTING
HOLE WITHIN 5°

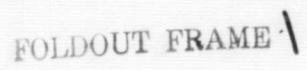
SOURCE CONTROL DRAWING

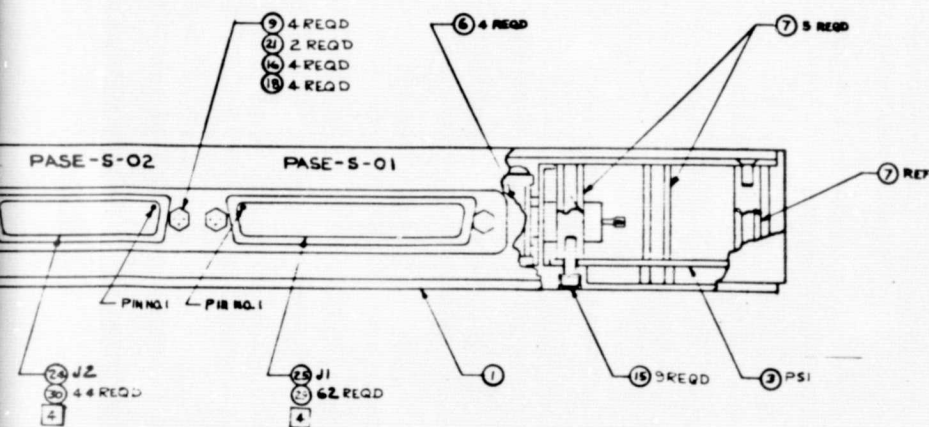
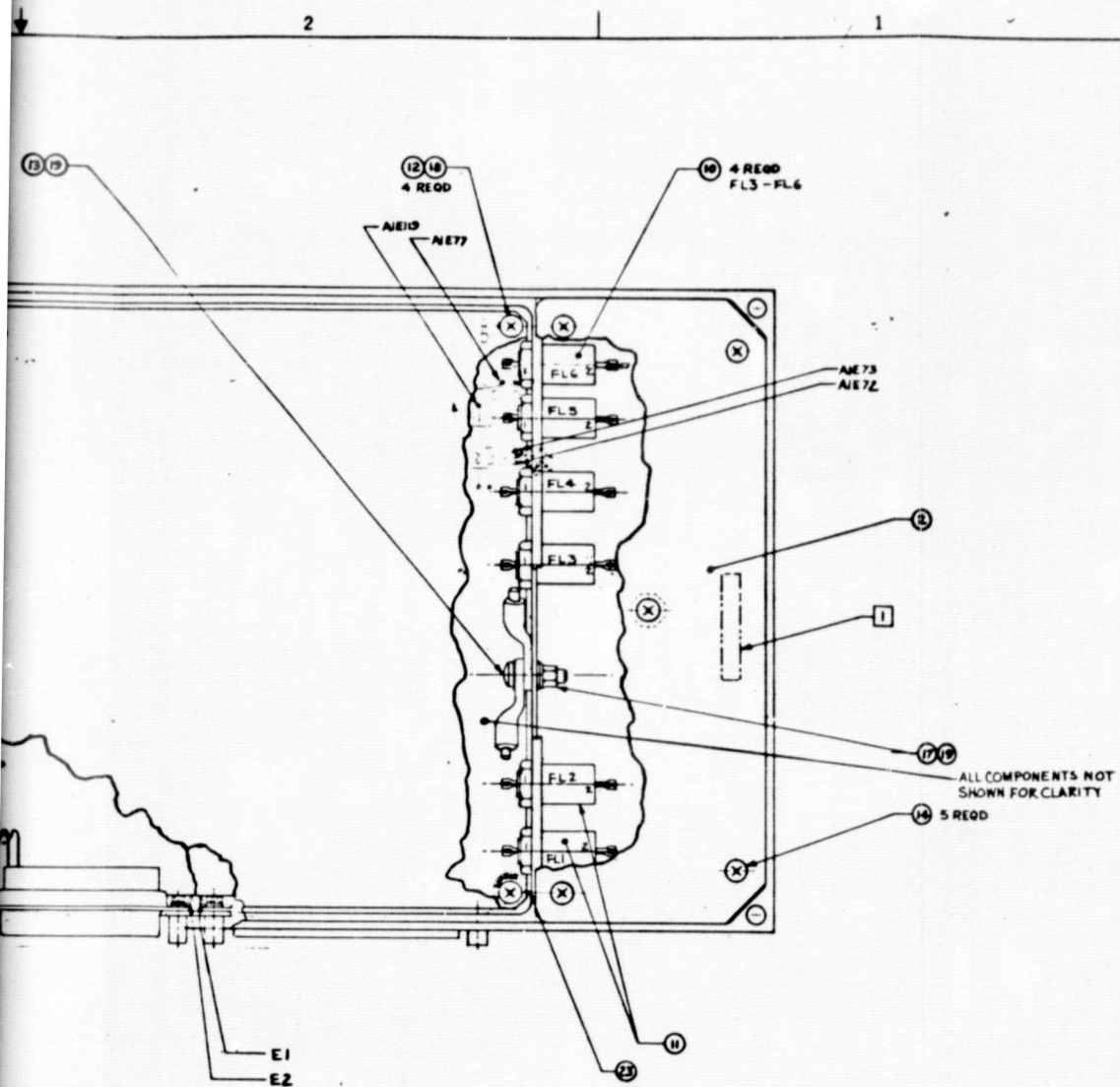
48035

2	2	2		35089-13	BEARING			7	
1	1	1		-3	MOTOR				
-501	-1	ITEM NO	CODE IDENT	PART NO	NOMENCLATURE	STOCK SIZE	MATERIAL DESCRIPTION REFERENCE DESIGNATION OR ELEC PWR	MATERIAL SPECIFICATION	

APPROVED		DATE	CONTRACT NO. 48035-1		APPROVED		DATE	Ball Brothers Research Corporation Boulder, Colorado 80302	
UNLESS OTHERWISE SPECIFIED		DIMENSIONS ARE IN INCHES TOLERANCES: XX .XXX .X" X .03 .010 .01"		DESIGNER		CHECKED		MOTOR, STEPPER	
BREAK SHARP EDGES MIL STD 12.15 USAN V3214, 846.1, Y14.8 SHOP STANDARDS 25000 THREADS PER N-38 SURFACE FINISH 125 EXCEPT AS NOTED LAYOUT NO. 47759		MATERIAL & PRICE 48035-1 48035-1 48035-1		PART NO		NEXT ASSY		USED ON	
APPLICATION		SCALE 2:1		WT		SHEET 1 OF 1		RELEASED 24 SEP 75	

FOLDOUT FRAME 2

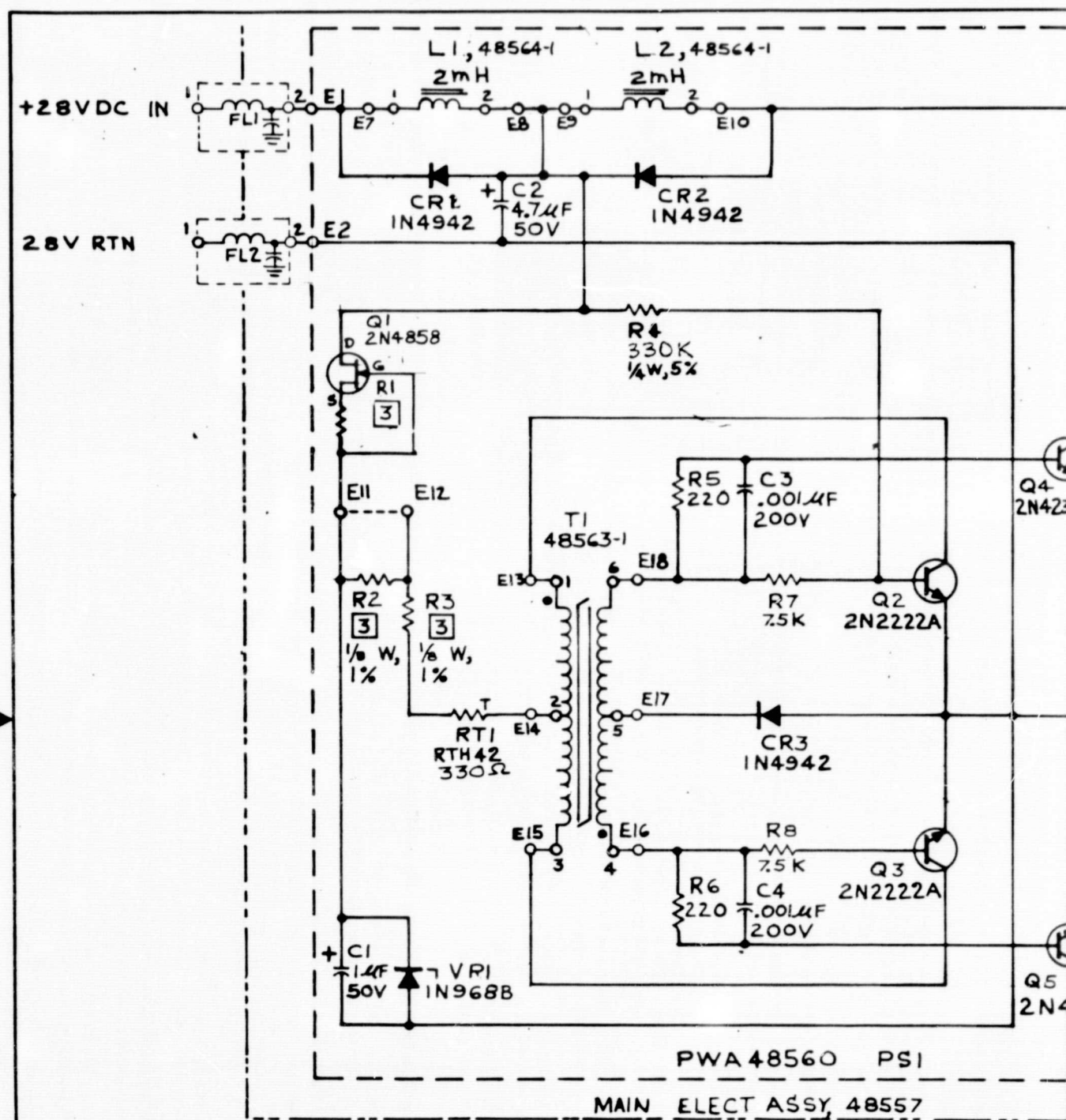




**REDUCED SIZE
DUPLICATE**
NO DIVISIONS TO BE
MADE TO THIS SHEET

BALL BROTHERS RESEARCH
E 13993 48557

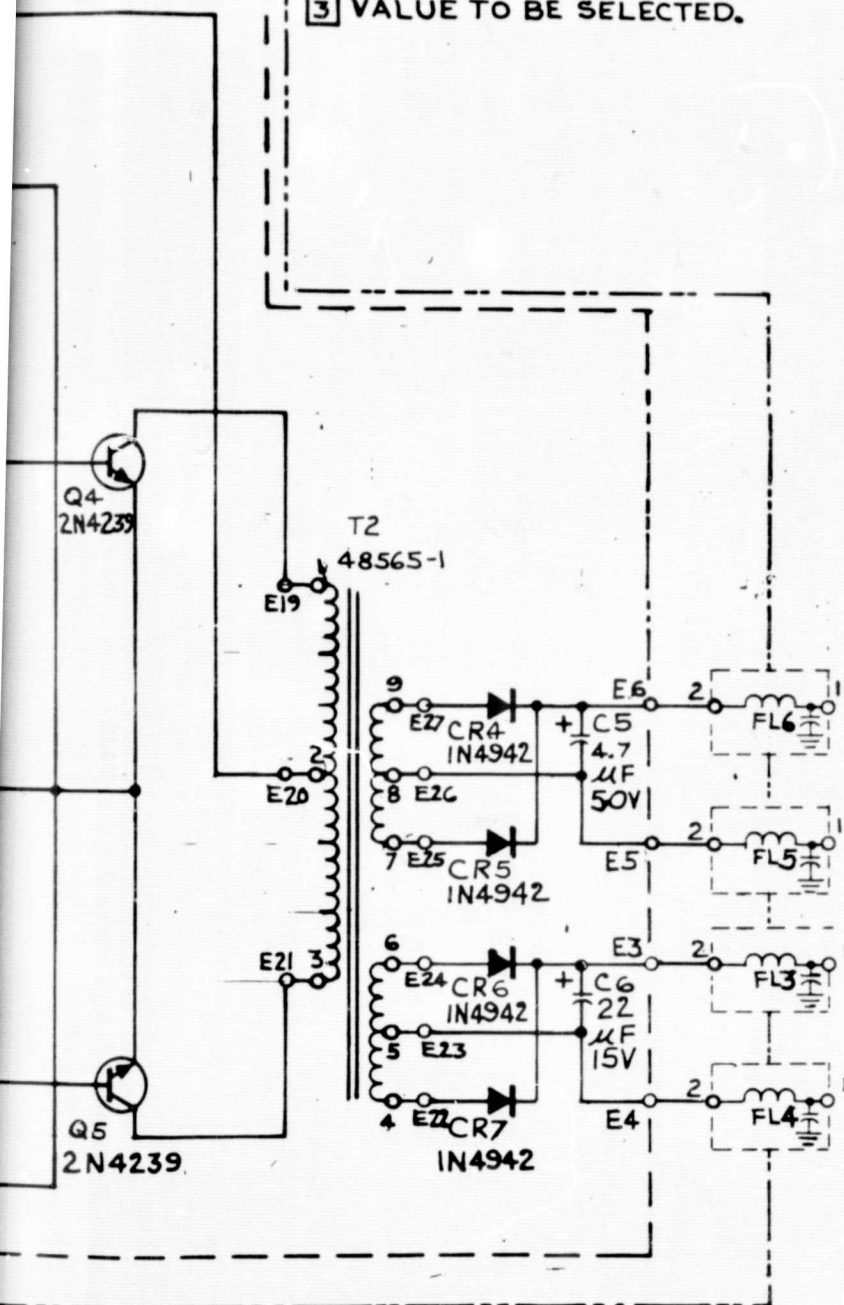
FOLDOUT FRAME 2



FOLDOUT FRAME

NOTES UNLESS OTHERWISE SPECIFIED
 1 ALL RESISTOR VALUES ARE IN OHMS.
 2 ALL RESISTORS ARE $\frac{1}{8}$ WATT, $\pm 5\%$.
 3 VALUE TO BE SELECTED.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	C8C6 VOLTAGE WAS 100V VRI WAS IN 968A, DWG ENGR RELEASED	4-28-75	500075 LW



ISOLATED PWR

ISOLATED PWR RTN

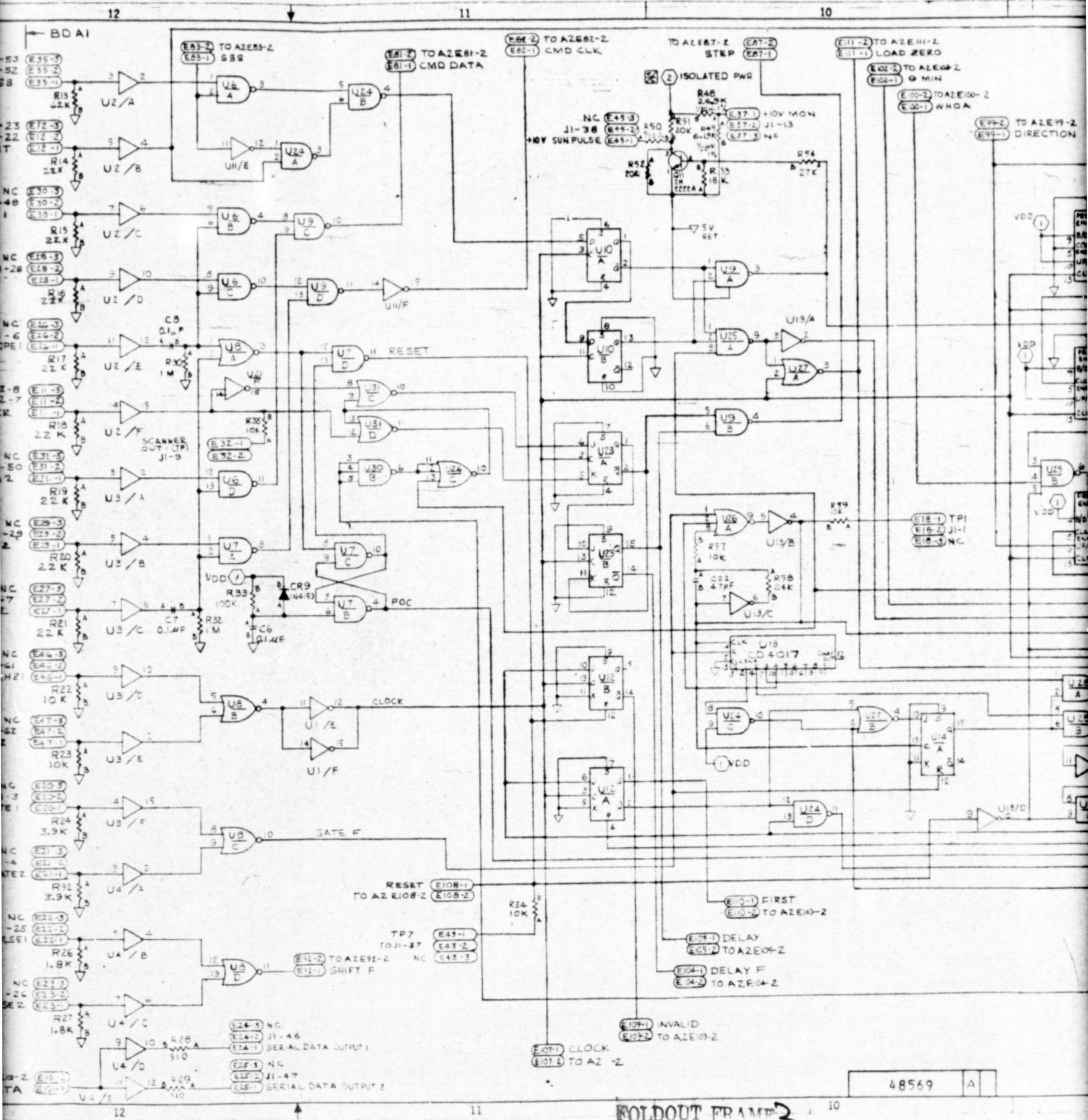
+5VDC

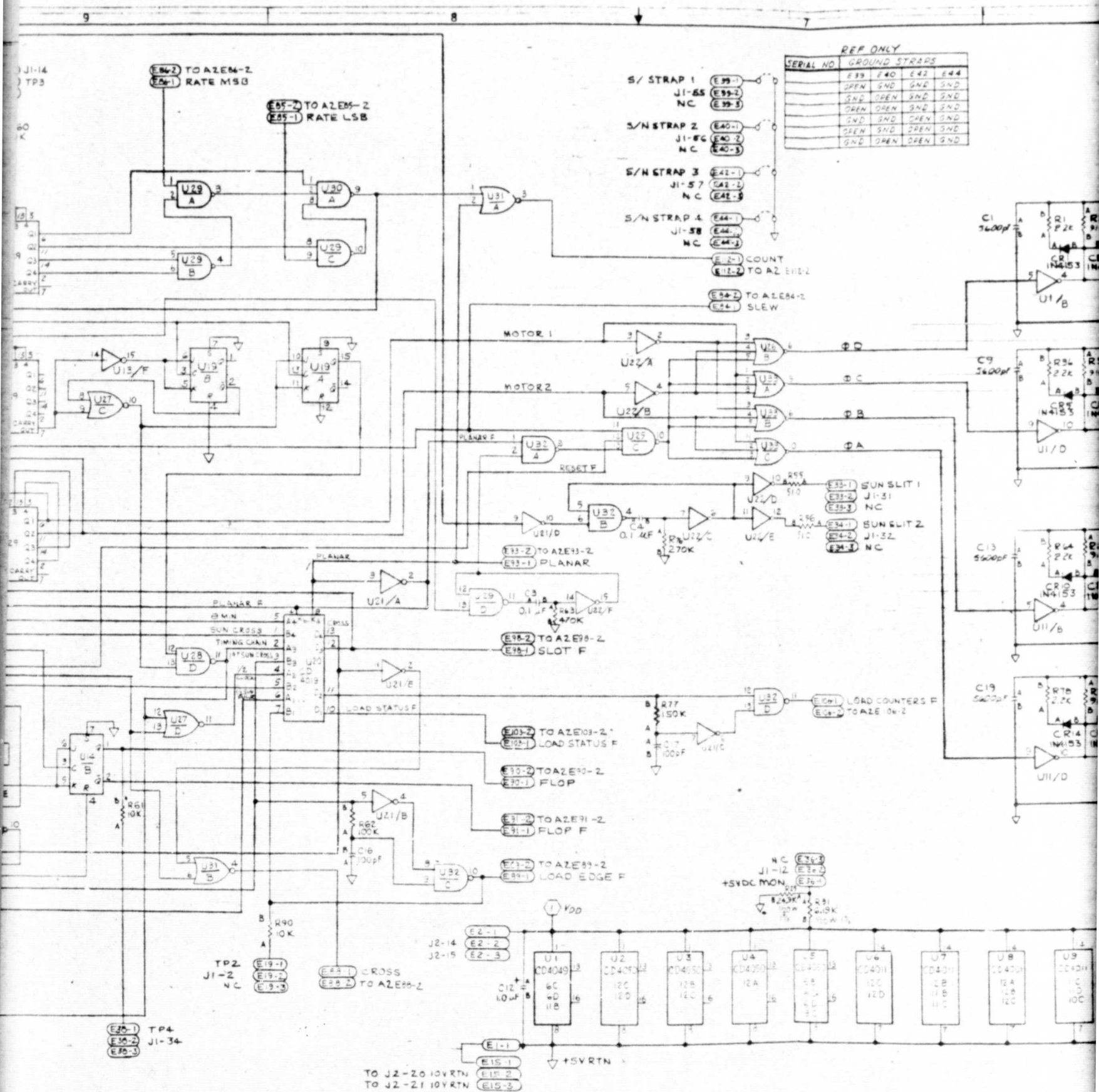
5V RTN

**REDUCED SIZE
DRAWING**

APPROVED		DATE	CONTRACT NO. NAS 5-20651		APPROVED	DATE	MATERIAL DESCRIPTION		MATERIAL SPECIFICATION
UNLESS OTHERWISE SPECIFIED		DIMENSIONS ARE IN INCHES TOLERANCES XX XXX XXXX X" + .03 + .010 BANG 1.1"		DESIGNER		GROUP ENG		SCHEMATIC DIAGRAM, LOW VOLTAGE POWER SUPPLY- PAS	
BREAK ALL SHARP EDGES		APPLICABLE SPECS: MIL STD 8 12 15 ASA Y 32 16 846 1		THREADS PER INCH SURFACE FINISH 125 EXCEPT AS NOTED		LAYOUT NO.		SIZE CODE IDENT NO. D 13993	
PART NO		NEXT ASSY	USED ON	BALL PROG.		SCALE NONE		SHEET 48561	
FINISH SPECIFICATION		APPLICATION		BALL PROG.		SCALE NONE		SHEET 48561	

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OF POOR QUALITY





48569

S/ STRAP 1 (E99-1)
J1-85 (E99-2)
NC (E99-3)

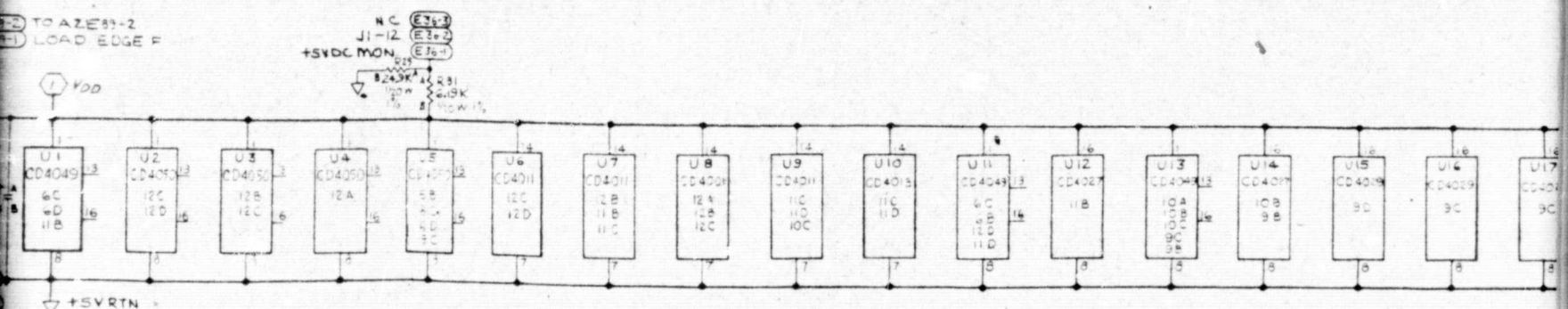
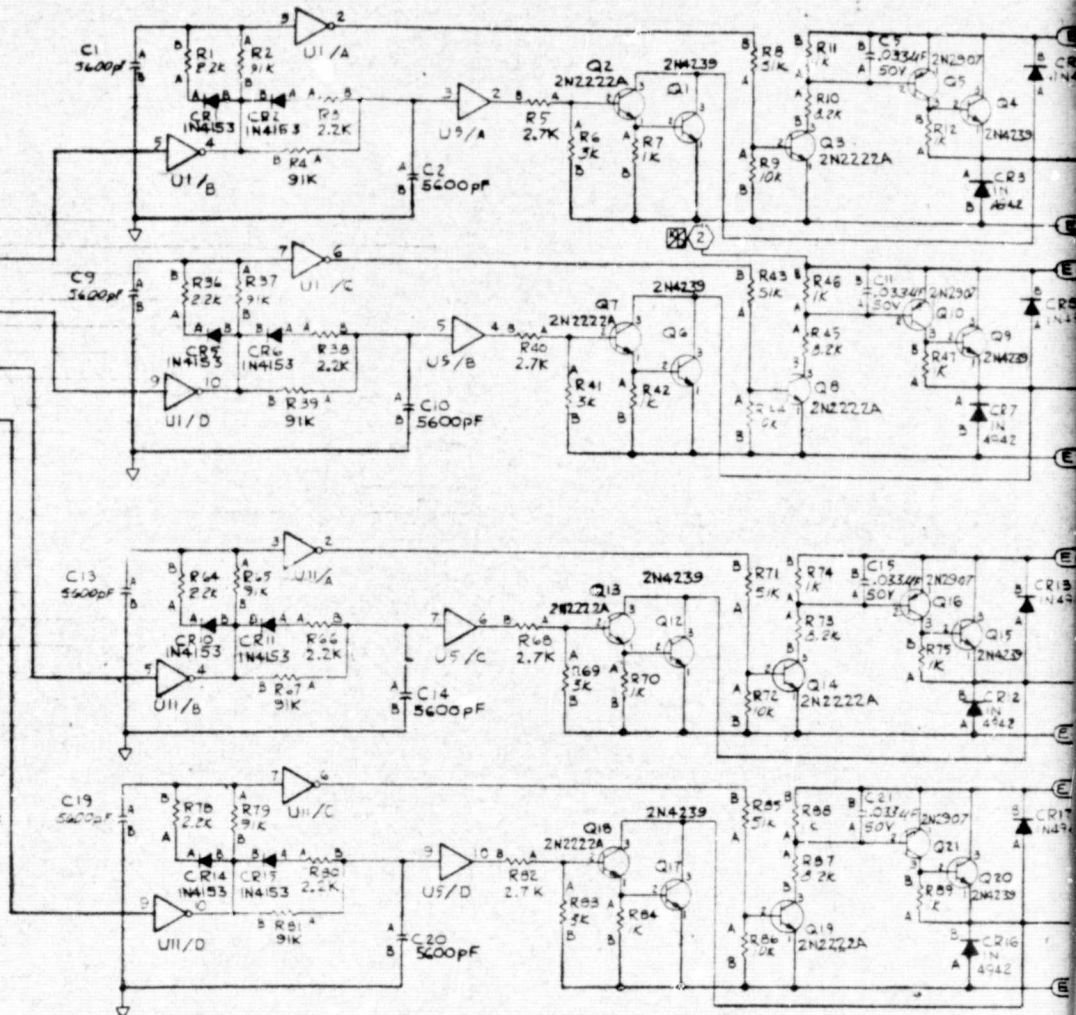
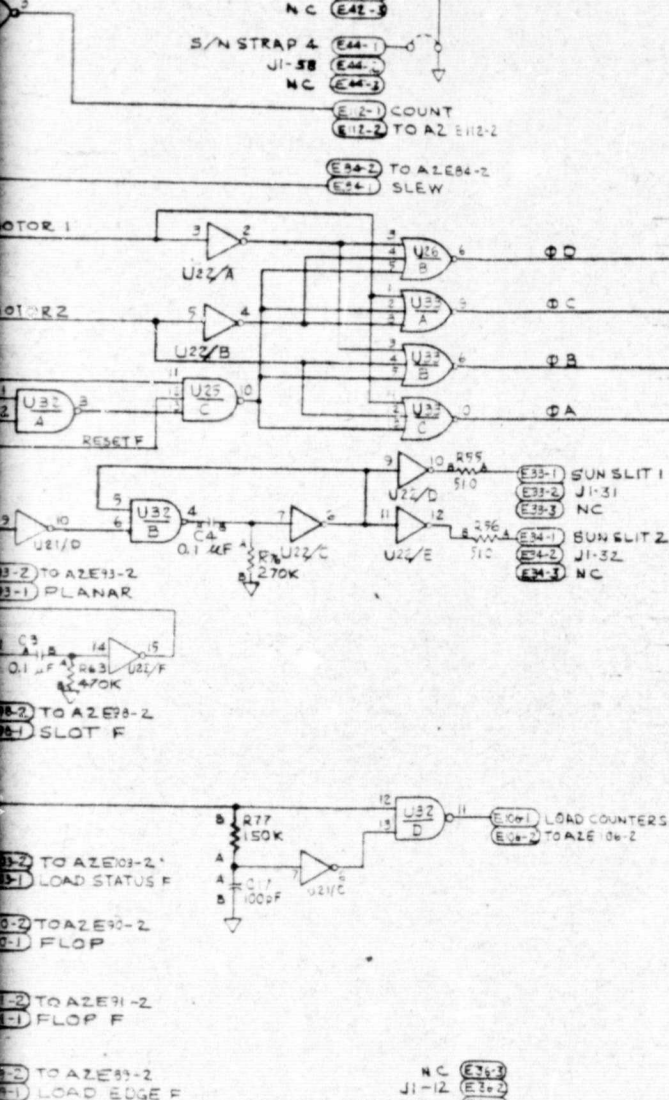
S/N STRAP 2 (E40-1)
J1-86 (E40-2)
NC (E40-3)

S/N STRAP 3 (E42-1)
J1-57 (E42-2)
NC (E42-3)

S/N STRAP 4 (E44-1)
J1-58 (E44-2)
NC (E44-3)

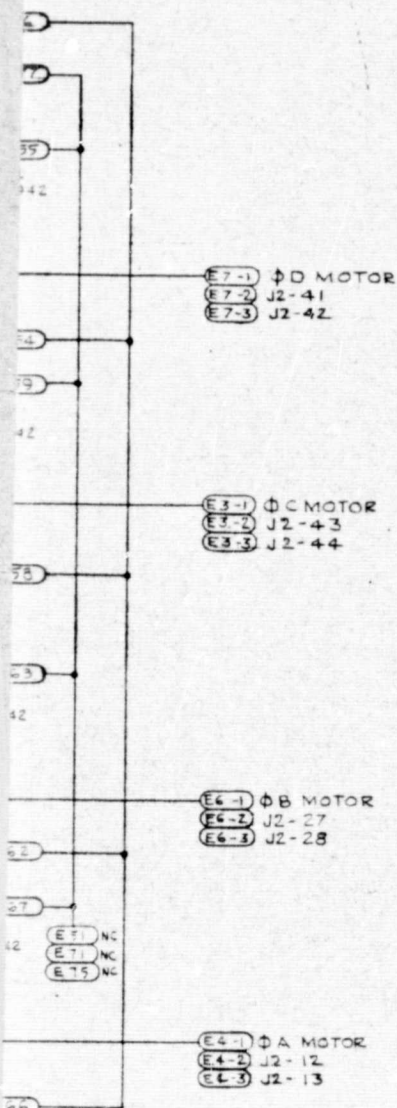
(E42-1) COUNT
(E42-2) TO A2 E42-2

(E44-2) TO A1E4-2
(E44-3) SLEW



FOLDOUT FRAME 4

ORIGINAL PAGE IS
OF POOR QUALITY



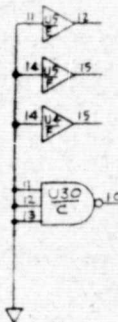
ENCODER A E8-1 E8-2 E8-3
JZ-9 JZ-10
E9-1 E9-2 E9-3
JZ-14 JZ-23

ENCODER B E9-1 E9-2 E9-3
JZ-14 JZ-23
E10-1 E10-2 E10-3
JZ-38 JZ-39

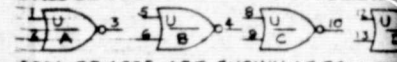
ENCODER C E10-1 E10-2 E10-3
JZ-38 JZ-39
E11-1 E11-2 E11-3
JZ-35 JZ-36

HOME E11-1 E11-2 E11-3
JZ-35 JZ-36

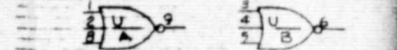
SPARES



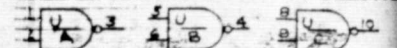
NOTES UNLESS OTHERWISE SPECIFIED
1 ALL RESISTOR VALUES IN OHMS
2 ALL RESISTORS ARE 1/2 WATT, ± 5%
3 ALL CD4001 ARE SHOWN AS FOLLOWS



4 ALL CD4025 ARE SHOWN AS FOLLOWS



5 ALL CD4011 ARE SHOWN AS FOLLOWS



6 ALL CD4023 ARE SHOWN AS FOLLOWS

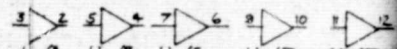


7 ALL CD4049 ARE SHOWN AS FOLLOWS



U/A U/B U/C U/D U/E

8 ALL CD4050 ARE SHOWN AS FOLLOWS



U/A U/B U/C U/D U/E

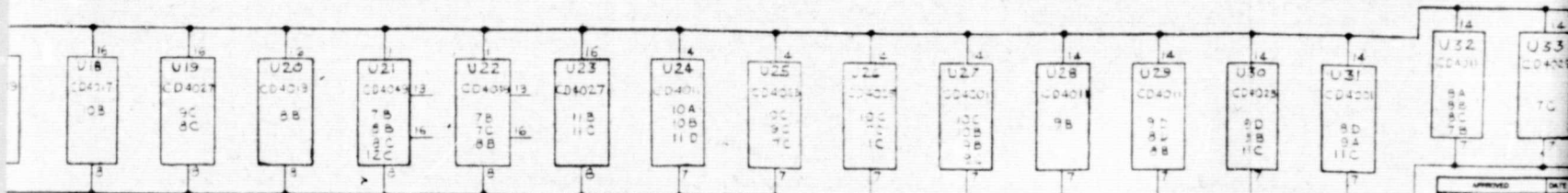
JZ-3 E17-3
JZ-2 E17-2
JZ-1 E17-1
JZ-19 E16-3
JZ-18 E16-2
JZ-17 E16-1
JZ-21 E48-3
JZ-20 E48-2
JZ-14 E48-1
JZ-42 E49-3
JZ-41 E49-2
JZ-40 E49-1

H0V E14-1 R91 A1 E77
JZ-6 E14-2 560Ω A1 E76
JZ-5 E14-3 1/2 W 5% A1 E72

A1 E73
J1-17 RT1
J1-18 RT2
J1-39 RT3
J1-40 RT4

SHOWN
THE HOS
A1, J1,
(CHAS

REDUCED SIZE
DRAWING



REDUCED SIZE
DRAWING

SV RTN 1 JZ-29 E1-2
SV RTN 2 JZ-30 E1-3
TO J1-18 E1-4
TO J1-19 E1-5

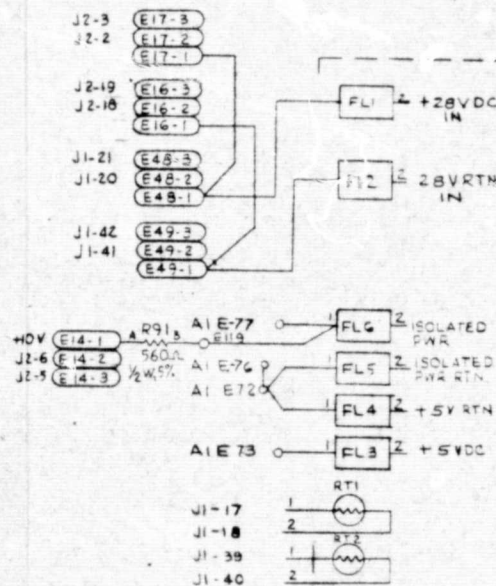
FOLDCUT FRAME 5

MAR 10 1977

NO REVISIONS TO BE
MADE TO THIS SHEET

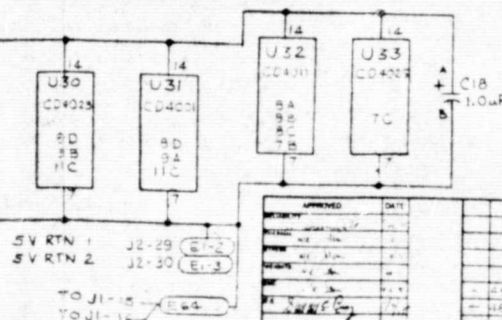
3 5 7 9 11 13 15

ALL ED 4050 ARE SHOWN AS FOLLOWS:



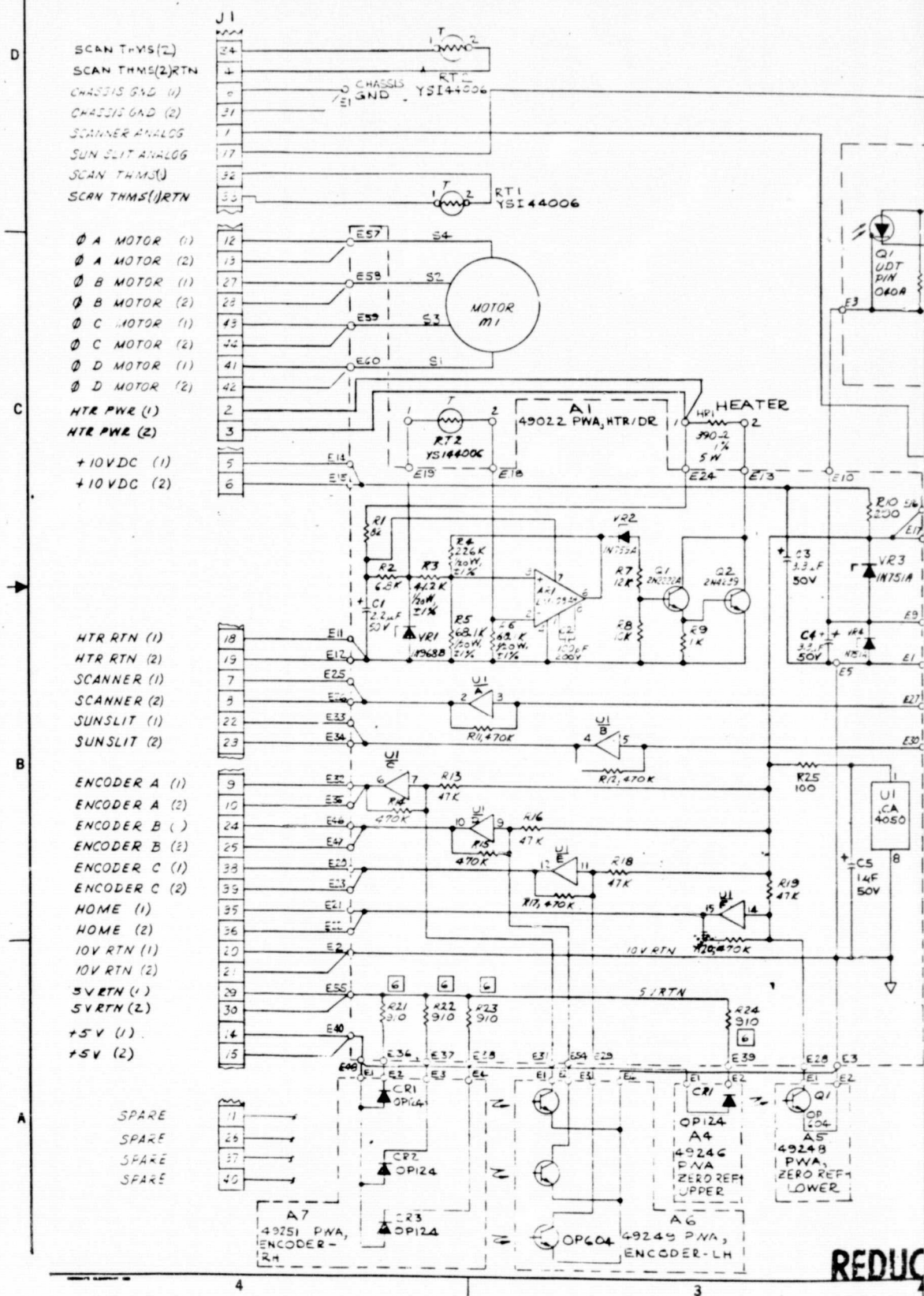
SHOWN TO COMPLETE
THE WOOK-UP OF
A1, J1 & J2
(CHASSIS MOUNTED)

**REDUCED SIZE
DRAWING**



FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY



REDUC

DUPI

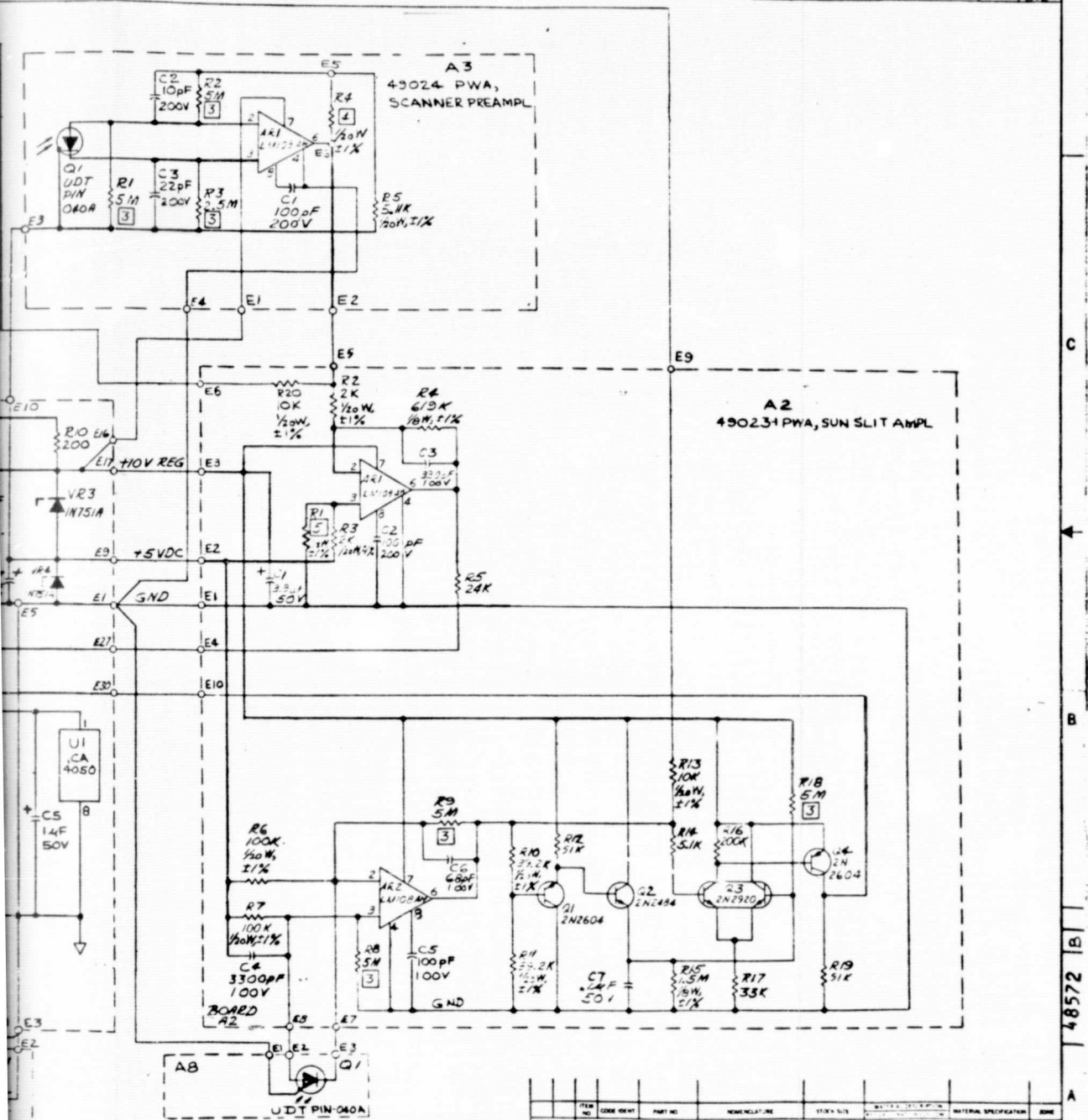
NO REVIS
MADE TO

FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY

- NOTES UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTANCE VALUES IN OHMS.
 2. ALL RESISTORS ARE 1/4WATT, ±5%.
 3. Caddock resistor type VVDS, 1WATT, 1% PER ST32155.
 4. VALUE TO BE SELECTED AT TEST, VOM VALUE 10K.
 5. VALUE TO BE SELECTED AT TEST, 510K MIN VALUE.
 6. VALUE TO BE SELECTED AT TEST, VOM VALUE 910Ω.
 7. A1E4, 6, 7, 8, 41, 42, 43, 44, 45, 49, 50, 51, 52, 53, 54 OMITTED

REV	DATE	BY	APP'D	REMARKS
1	11-1-68	J. H. HAYES		INITIAL DESIGN
2	11-1-68	J. H. HAYES		REVISION 1
3	11-1-68	J. H. HAYES		REVISION 2
4	11-1-68	J. H. HAYES		REVISION 3
5	11-1-68	J. H. HAYES		REVISION 4
6	11-1-68	J. H. HAYES		REVISION 5
7	11-1-68	J. H. HAYES		REVISION 6
8	11-1-68	J. H. HAYES		REVISION 7
9	11-1-68	J. H. HAYES		REVISION 8
10	11-1-68	J. H. HAYES		REVISION 9
11	11-1-68	J. H. HAYES		REVISION 10
12	11-1-68	J. H. HAYES		REVISION 11
13	11-1-68	J. H. HAYES		REVISION 12
14	11-1-68	J. H. HAYES		REVISION 13
15	11-1-68	J. H. HAYES		REVISION 14
16	11-1-68	J. H. HAYES		REVISION 15
17	11-1-68	J. H. HAYES		REVISION 16
18	11-1-68	J. H. HAYES		REVISION 17
19	11-1-68	J. H. HAYES		REVISION 18
20	11-1-68	J. H. HAYES		REVISION 19
21	11-1-68	J. H. HAYES		REVISION 20
22	11-1-68	J. H. HAYES		REVISION 21
23	11-1-68	J. H. HAYES		REVISION 22
24	11-1-68	J. H. HAYES		REVISION 23
25	11-1-68	J. H. HAYES		REVISION 24
26	11-1-68	J. H. HAYES		REVISION 25
27	11-1-68	J. H. HAYES		REVISION 26
28	11-1-68	J. H. HAYES		REVISION 27
29	11-1-68	J. H. HAYES		REVISION 28
30	11-1-68	J. H. HAYES		REVISION 29
31	11-1-68	J. H. HAYES		REVISION 30
32	11-1-68	J. H. HAYES		REVISION 31
33	11-1-68	J. H. HAYES		REVISION 32
34	11-1-68	J. H. HAYES		REVISION 33
35	11-1-68	J. H. HAYES		REVISION 34
36	11-1-68	J. H. HAYES		REVISION 35
37	11-1-68	J. H. HAYES		REVISION 36
38	11-1-68	J. H. HAYES		REVISION 37
39	11-1-68	J. H. HAYES		REVISION 38
40	11-1-68	J. H. HAYES		REVISION 39
41	11-1-68	J. H. HAYES		REVISION 40
42	11-1-68	J. H. HAYES		REVISION 41
43	11-1-68	J. H. HAYES		REVISION 42
44	11-1-68	J. H. HAYES		REVISION 43
45	11-1-68	J. H. HAYES		REVISION 44
46	11-1-68	J. H. HAYES		REVISION 45
47	11-1-68	J. H. HAYES		REVISION 46
48	11-1-68	J. H. HAYES		REVISION 47
49	11-1-68	J. H. HAYES		REVISION 48
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51	11-1-68	J. H. HAYES		REVISION 50
52	11-1-68	J. H. HAYES		REVISION 51
53	11-1-68	J. H. HAYES		REVISION 52
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56	11-1-68	J. H. HAYES		REVISION 55
57	11-1-68	J. H. HAYES		REVISION 56
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60	11-1-68	J. H. HAYES		REVISION 59
61	11-1-68	J. H. HAYES		REVISION 60
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63	11-1-68	J. H. HAYES		REVISION 62
64	11-1-68	J. H. HAYES		REVISION 63
65	11-1-68	J. H. HAYES		REVISION 64
66	11-1-68	J. H. HAYES		REVISION 65
67	11-1-68	J. H. HAYES		REVISION 66
68	11-1-68	J. H. HAYES		REVISION 67
69	11-1-68	J. H. HAYES		REVISION 68
70	11-1-68	J. H. HAYES		REVISION 69
71	11-1-68	J. H. HAYES		REVISION 70
72	11-1-68	J. H. HAYES		REVISION 71
73	11-1-68	J. H. HAYES		REVISION 72
74	11-1-68	J. H. HAYES		REVISION 73
75	11-1-68	J. H. HAYES		REVISION 74
76	11-1-68	J. H. HAYES		REVISION 75
77	11-1-68	J. H. HAYES		REVISION 76
78	11-1-68	J. H. HAYES		REVISION 77
79	11-1-68	J. H. HAYES		REVISION 78
80	11-1-68	J. H. HAYES		REVISION 79
81	11-1-68	J. H. HAYES		REVISION 80
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83	11-1-68	J. H. HAYES		REVISION 82
84	11-1-68	J. H. HAYES		REVISION 83
85	11-1-68	J. H. HAYES		REVISION 84
86	11-1-68	J. H. HAYES		REVISION 85
87	11-1-68	J. H. HAYES		REVISION 86
88	11-1-68	J. H. HAYES		REVISION 87
89	11-1-68	J. H. HAYES		REVISION 88
90	11-1-68	J. H. HAYES		REVISION 89
91	11-1-68	J. H. HAYES		REVISION 90
92	11-1-68	J. H. HAYES		REVISION 91
93	11-1-68	J. H. HAYES		REVISION 92
94	11-1-68	J. H. HAYES		REVISION 93
95	11-1-68	J. H. HAYES		REVISION 94
96	11-1-68	J. H. HAYES		REVISION 95
97	11-1-68	J. H. HAYES		REVISION 96
98	11-1-68	J. H. HAYES		REVISION 97
99	11-1-68	J. H. HAYES		REVISION 98
100	11-1-68	J. H. HAYES		REVISION 99
101	11-1-68	J. H. HAYES		REVISION 100



REV	DATE	BY	APP'D	REMARKS
1	11-1-68	J. H. HAYES		INITIAL DESIGN
2	11-1-68	J. H. HAYES		REVISION 1
3	11-1-68	J. H. HAYES		REVISION 2
4	11-1-68	J. H. HAYES		REVISION 3
5	11-1-68	J. H. HAYES		REVISION 4
6	11-1-68	J. H. HAYES		REVISION 5
7	11-1-68	J. H. HAYES		REVISION 6
8	11-1-68	J. H. HAYES		REVISION 7
9	11-1-68	J. H. HAYES		REVISION 8
10	11-1-68	J. H. HAYES		REVISION 9
11	11-1-68	J. H. HAYES		REVISION 10
12	11-1-68	J. H. HAYES		REVISION 11
13	11-1-68	J. H. HAYES		REVISION 12
14	11-1-68	J. H. HAYES		REVISION 13
15	11-1-68	J. H. HAYES		REVISION 14
16	11-1-68	J. H. HAYES		REVISION 15
17	11-1-68	J. H. HAYES		REVISION 16
18	11-1-68	J. H. HAYES		REVISION 17
19	11-1-68	J. H. HAYES		REVISION 18
20	11-1-68	J. H. HAYES		REVISION 19
21	11-1-68	J. H. HAYES		REVISION 20
22	11-1-68	J. H. HAYES		REVISION 21
23	11-1-68	J. H. HAYES		REVISION 22
24	11-1-68	J. H. HAYES		REVISION 23
25	11-1-68	J. H. HAYES		REVISION 24
26	11-1-68	J. H. HAYES		REVISION 25
27	11-1-68	J. H. HAYES		REVISION 26
28	11-1-68	J. H. HAYES		REVISION 27
29	11-1-68	J. H. HAYES		REVISION 28
30	11-1-68	J. H. HAYES		REVISION 29
31	11-1-68	J. H. HAYES		REVISION 30
32	11-1-68	J. H. HAYES		REVISION 31
33	11-1-68	J. H. HAYES		REVISION 32
34	11-1-68	J. H. HAYES		REVISION 33
35	11-1-68	J. H. HAYES		REVISION 34
36	11-1-68	J. H. HAYES		REVISION 35
37	11-1-68	J. H. HAYES		REVISION 36
38	11-1-68	J. H. HAYES		REVISION 37
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98	11-1-68	J. H. HAYES		REVISION 97
99	11-1-68	J. H. HAYES		REVISION 98
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101	11-1-68	J. H. HAYES		REVISION 100

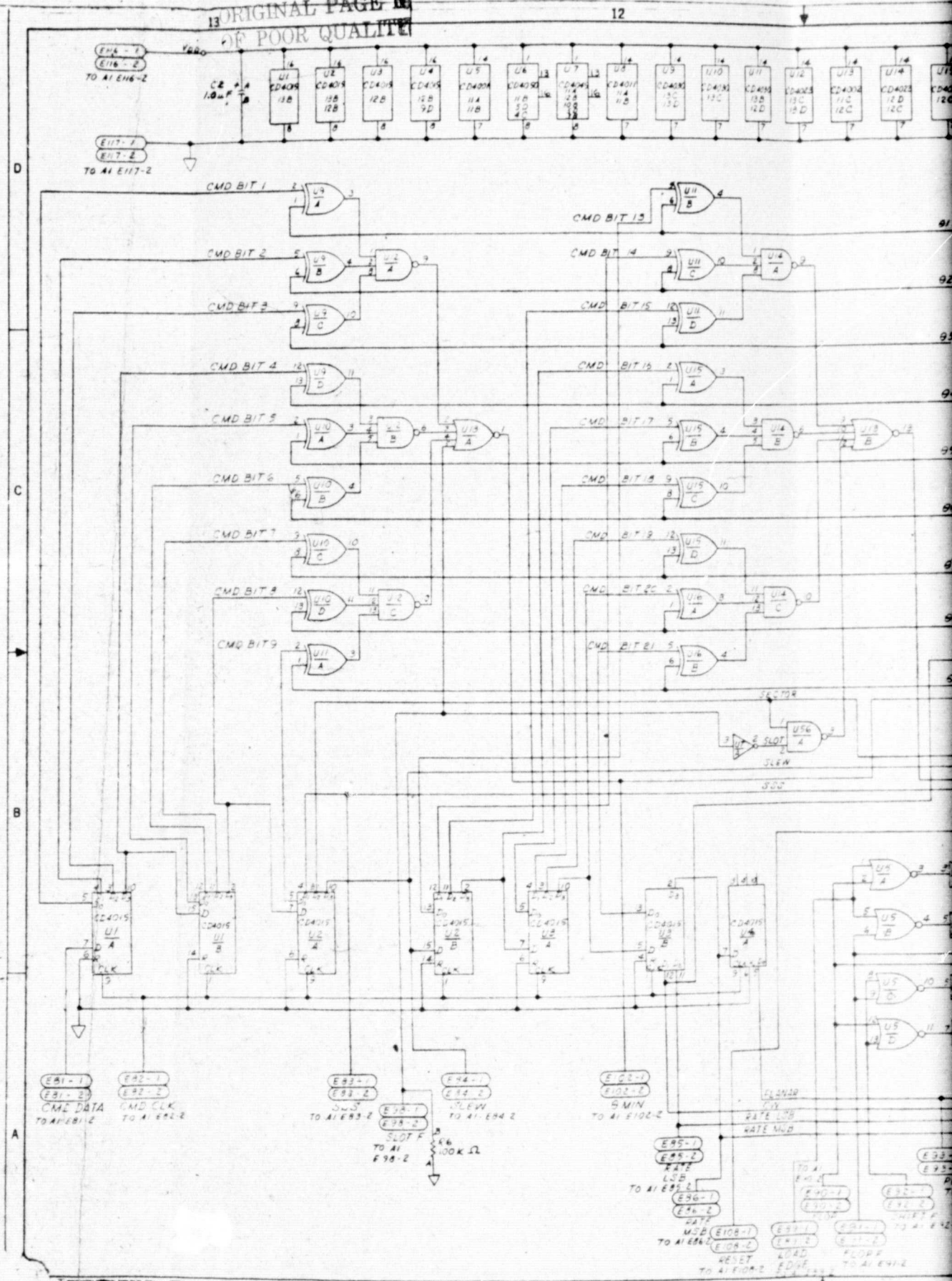
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RELEASED 11/1/68

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1825



FOLDOUT FRAME

1934



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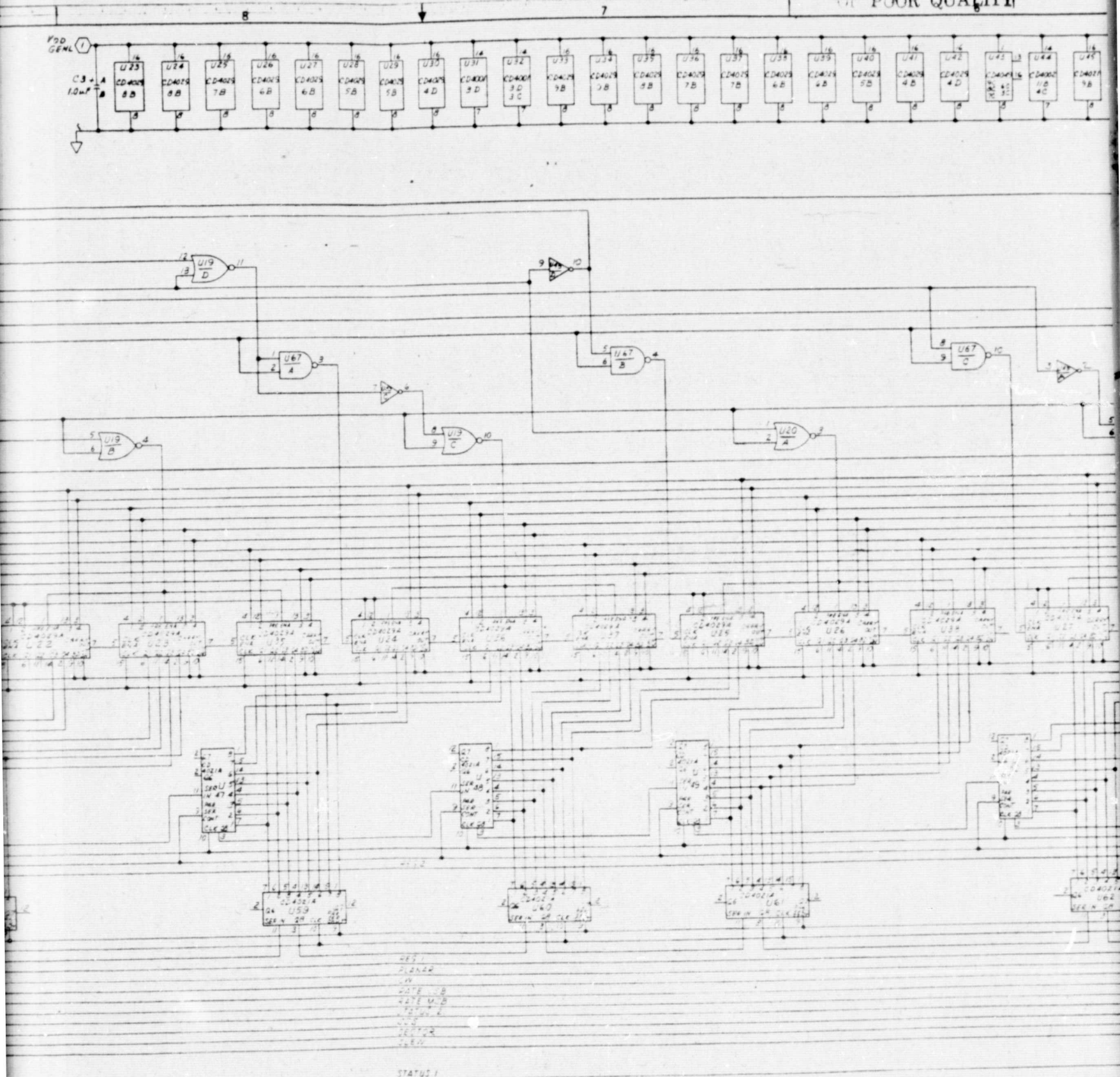
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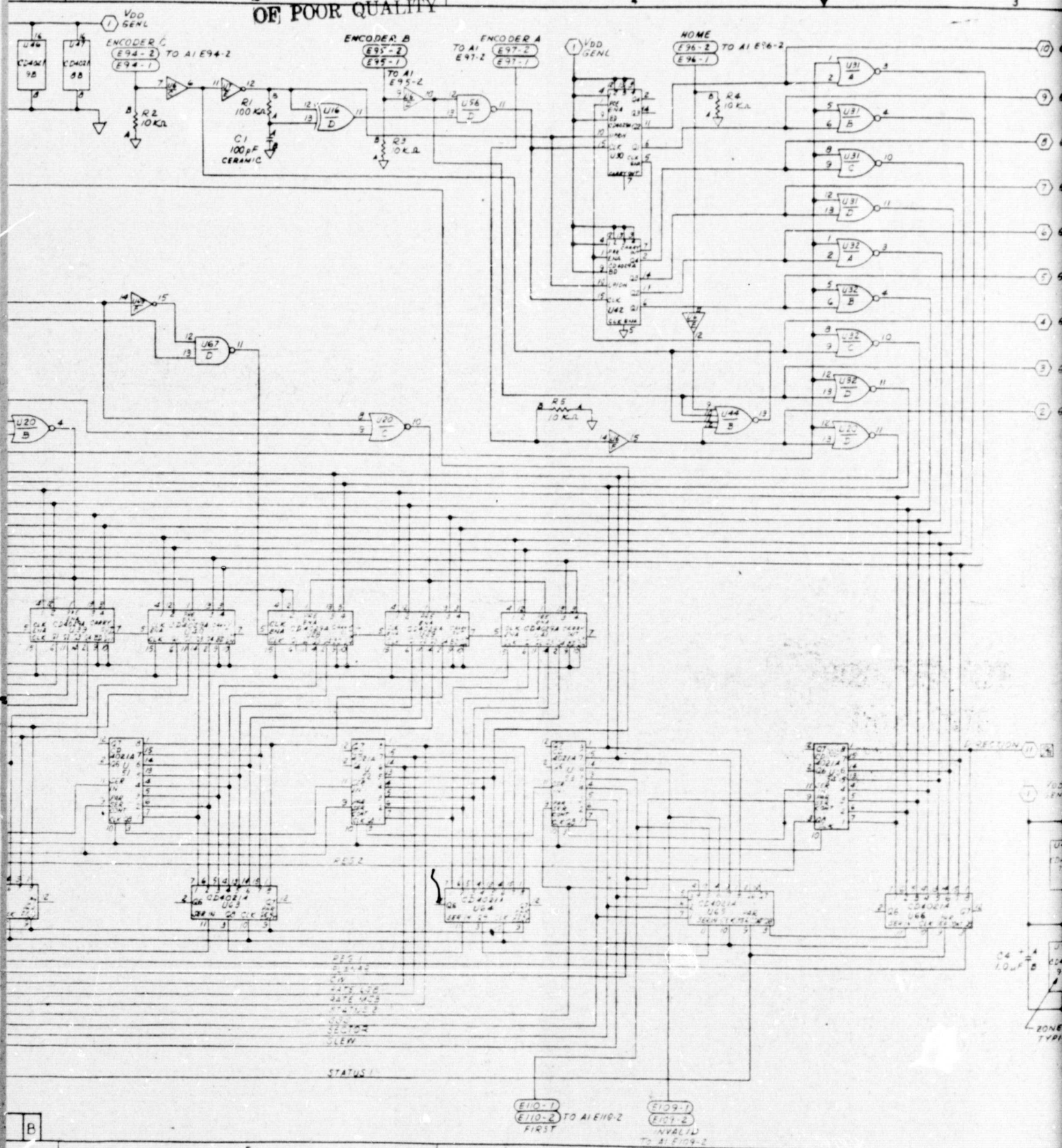
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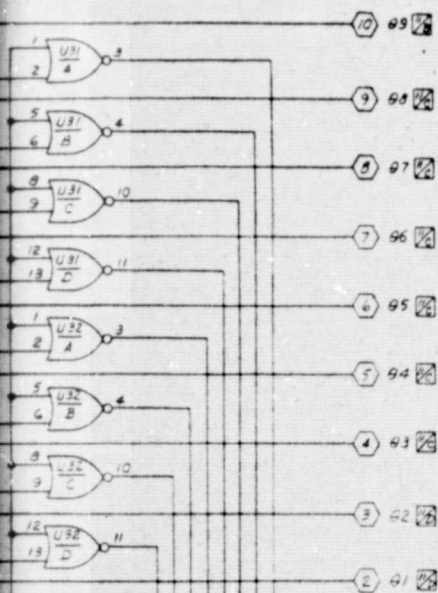
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WOLDOUT FRAME 4

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FOLDOUT FRAME 5

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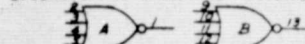
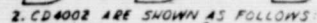


NOTES UNLESS OTHERWISE SPECIFIED

1. RESISTORS ARE $\frac{1}{8}W$ 5% C.C.
2. CD4001 ARE SHOWN AS FOLLOWS:
-
- ```

graph LR
 A[NOT A] -- 1 --> A
 A -- 3 --> A
 B[NOT B] -- 5 --> B
 B -- 4 --> B
 C[NOT C] -- 2 --> C
 C -- 9 --> C

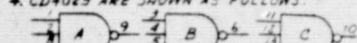
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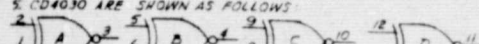
3. CD4011 ARE SHOWN AS FOLLOWS:



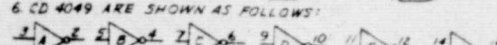
- 4 CD4038 ARE SHOWN AS FOLLOWS.



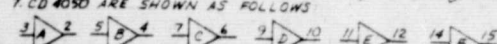
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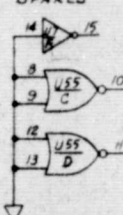
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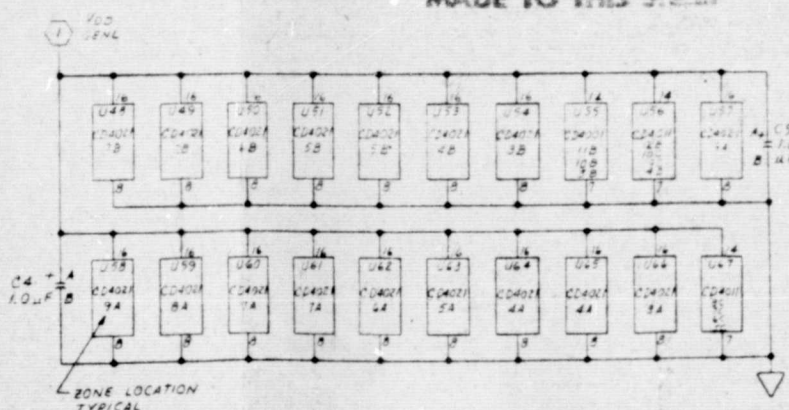
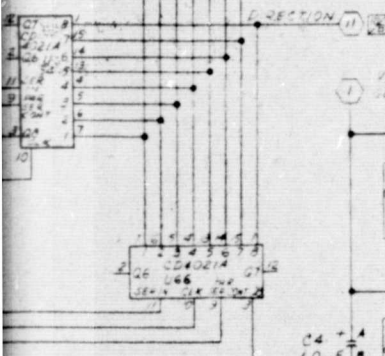


SPARES



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DUPLICATE

NO REVISIONS TO BE  
MADE TO THIS SHEET



**REDUCED SIZE  
DRAWING**

[illegible]

**WOLDOUT FRAME**



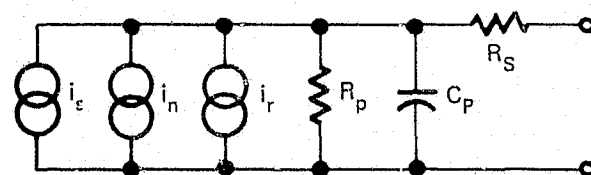
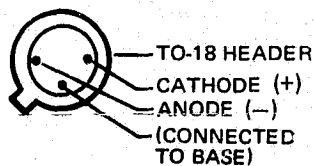
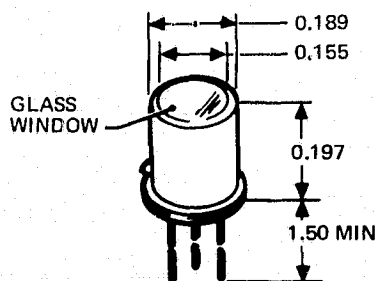


APPENDIX B

DETECTOR DATA SHEET



|                    | Pin-020A            |                    |     | Pin-020B            |                    |      | Pin-040A   |                    |     | Pin-040B            |                    |      | Units                            |
|--------------------|---------------------|--------------------|-----|---------------------|--------------------|------|------------|--------------------|-----|---------------------|--------------------|------|----------------------------------|
| Dark Current       | Min                 | Typ                | Max | Min                 | Typ                | Max  | Min        | Typ                | Max | Min                 | Typ                | Max  |                                  |
| -5 Volts           |                     | 50                 | 150 |                     |                    | 800  |            | 200                | 400 |                     |                    | 4000 | Pico amp                         |
| -10 Volts          |                     | 75                 | 250 |                     |                    | 1000 |            | 300                | 600 |                     |                    | 6000 | Pico amp                         |
| Responsivity Peak  |                     | .42                |     |                     | .42                |      |            | .42                |     |                     | .42                |      | $\frac{\text{amp}}{\text{watt}}$ |
| N.E.P.             |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| 1000 c.p.s. Center | $6 \times 10^{-15}$ |                    |     | $2 \times 10^{-14}$ |                    |      | $10^{-14}$ |                    |     | $9 \times 10^{-14}$ |                    |      | watt                             |
| 1 c.p.s. Bandwidth |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| 1-5 Volt Bias      |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| 8500 Å             |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| Capacity           |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| -5 Volts           |                     | 5                  |     |                     | 5                  |      |            | 20                 |     |                     | 20                 |      | pf                               |
| -10 Volts          |                     | 4                  |     |                     | 4                  |      |            | 16                 |     |                     | 16                 |      | pf                               |
| -20 Volts          |                     | 3                  |     |                     | 3                  |      |            | 12                 |     |                     | 12                 |      | pf                               |
| Response Time      |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| 20 Volts, 50 ohms  |                     |                    | 5   |                     |                    | 5    |            |                    | 5   |                     |                    | 5    | ns                               |
| Maximum Steady     |                     |                    |     |                     |                    |      |            |                    |     |                     |                    |      |                                  |
| Reverse Voltage    |                     |                    | 25  |                     |                    | 25   |            |                    | 25  |                     |                    | 25   | Volts                            |
| Active Diameter    |                     | 20                 |     |                     | 20                 |      |            | 40                 |     |                     | 40                 |      | Thousandths                      |
| Active Area        |                     | $2 \times 10^{-3}$ |     |                     | $2 \times 10^{-3}$ |      |            | $8 \times 10^{-3}$ |     |                     | $8 \times 10^{-3}$ |      | cm <sup>2</sup>                  |



- $i_s$  = Signal current  $\approx 0.5 \mu\text{A}/\mu\text{W}$   
 $i_n$  = Shot noise current  
 $< 3 \times 10^{-15} \text{ amp/Hz}^{1/2}$  PIN-020A  
 $< 10^{-14} \text{ amp/Hz}^{1/2}$  PIN-040A  
 $i_r$  = Dark current  
 $R_p$  =  $\approx 10^{11} \text{ ohm}$   
 $R_s$  =  $< 50 \text{ ohm}$



UNITED DETECTOR TECHNOLOGY INC.



APPENDIX C  
POWER SUPPLY FREQUENCY

a-2



Date Sheet 1

3.2 SERIAL NUMBER

- S/N 002 RETEST PER MOR A30166
- Signature of Test Operator D. J. Pr. Daniel
- Start of Test 8/24/76
- End of Test 8/24/76

3.3 EQUIPMENT REQUIRED

- Temperature Chamber, Delta Designs Model 6545L or equivalent, N/A, S/N 267.
- Temperature Indicator, Minco Model 100A or equivalent, N/A, S/N 3852, calibration due FEB 6, 77.
- Oscilloscope and Camera, Tektronix 547 or equivalent, 7633, S/N C-9002, calibration due NOV 17, 76.
- Frequency Counter, HP5245L or equivalent HP 5246L, S/N 6762, calibration due JAN 21, 77.
- DVM Plug In, HP5265A or equivalent HP3465A, S/N C-9247, calibration due JAN 1, 77.
- Current Meter, Weston 911 or equivalent N/A, S/N 464, calibration due JAN 2, 77.
- Power Supply, HP6114A or equivalent N/A, S/N C-8795, calibration due JAN 22, 77.
- Decade Resistor Box, GR-1432-M or equivalent ~~N/A~~ N/R, S/N N/R, calibration due ~~JAN 2, 77~~ N/R.
- Decade Resistor Box, GR-1432-M or equivalent N/R, S/N N/R, calibration due N/R.
- VOM, Simpson 260 or equivalent N/A, S/N B100, calibration due OCT 6, 76.

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BOULDER COLORADO 80302DOC NO 49960

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 17 REV \_\_\_\_\_

## Data Sheet 2

3.5.2 Power Supply Current.

Check ✓

4.1 Visual Inspection.

Check ✓4.4.1 EQ1 (2N4858) Gate Voltage  
S/N 127.300 V.4.4.2  $R1 = EQ1 \times 100 \frac{\text{ohms}}{\text{volt}}$ 30  $\Omega$ 

4.5.2 R1 Selection

Record R1 Setting.

N/A  $\Omega$ 

Record Nearest 5% Value.

N/A  $\Omega$ 

4.5.3 R3 Selection

Record R3 Setting.

N/A  $\Omega$ 

Record Nearest 1% Standard Value

N/A  $\Omega$ 

4.5.7 Record Frequency

Measured

\_\_\_\_\_ kHz

Reference

N/A Only

4.5.9 R2 Selection

Record R2 setting

N/A  $\Omega$ 

Record nearest 1% standard value

N/A  $\Omega$ 

4.6.4 No-Load Input Current

Measured34 mA.Requirement25  $\pm$  15 mA.

4.6.6 Full-Load Input Current

Measured173 mA.Requirement160  $\pm$  20 mA.

4.7.1 Zener Voltage

Measured20.05 V.Requirement20  $\pm$  2 V.



## Data Sheet 2 (Continued)

|        |                                    |                        |
|--------|------------------------------------|------------------------|
| 4.7.2  | +5 Volt Measurement                |                        |
|        | <u>Measurement</u>                 | <u>Requirement</u>     |
|        | <u>5.49</u> V.                     | 5.6 $\pm$ 1.0 V.       |
| 4.7.3  | +20 Volt Measurement               |                        |
|        | <u>Measurement</u>                 | <u>Requirement</u>     |
|        | <u>20.69</u> V.                    | 20 $\pm$ 2.0 V.        |
| 4.8.5  | +5V Ripple Measurement             |                        |
|        | <u>Measurement</u>                 | <u>Requirement</u>     |
|        | <u>0.030</u> V. Pk - Pk            | $\leq$ 0.05 V. Pk - Pk |
| 4.8.7  | +20V Ripple Measurement            |                        |
|        | <u>Measurement</u>                 | <u>Requirement</u>     |
|        | <u>0.025</u> V. Pk - Pk            | $\leq$ 0.25 V. Pk - Pk |
| 4.9.1  | Fast Turn-On Check                 |                        |
|        |                                    | <u>✓</u> Check         |
| 4.10.2 | Isolation Resistance               |                        |
|        | <u>Measurement</u>                 | <u>Requirement</u>     |
|        | <u>710 m<math>\Omega</math></u> V. | $\geq$ 1M $\Omega$     |





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DATE

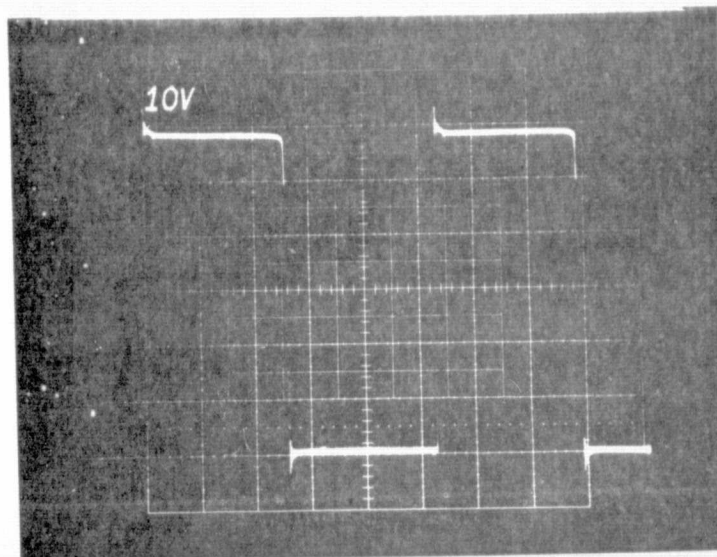
SHEET 19 REV

CODE IDENT NO 13993

Data Sheet 3

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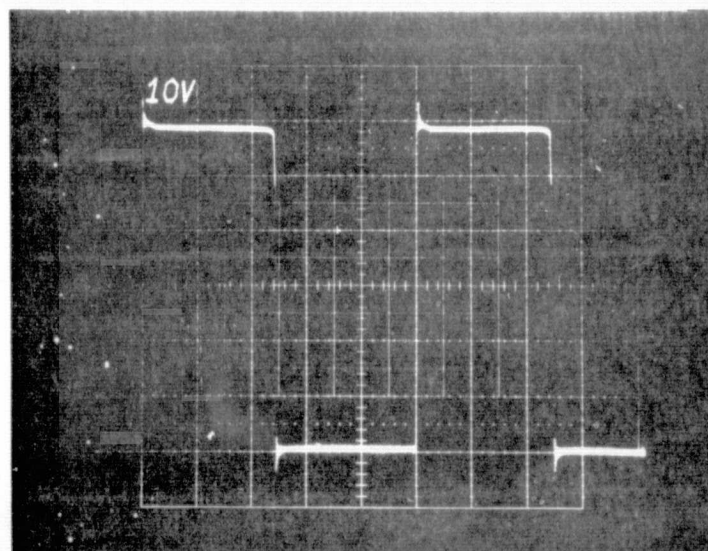


10V/cm

10uS/cm

19KHz Switching Wave Shape

4.8.3



10V/cm

10uS/cm

20KHz Switching Wave Shape



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DATE

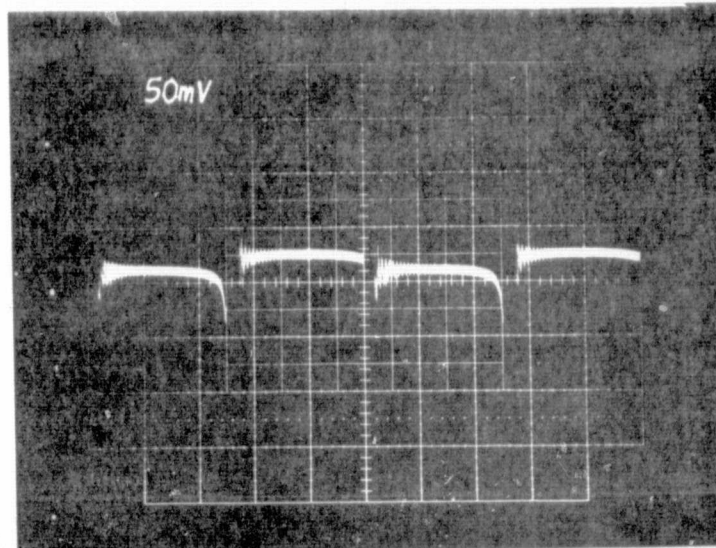
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SHEET 20 REV

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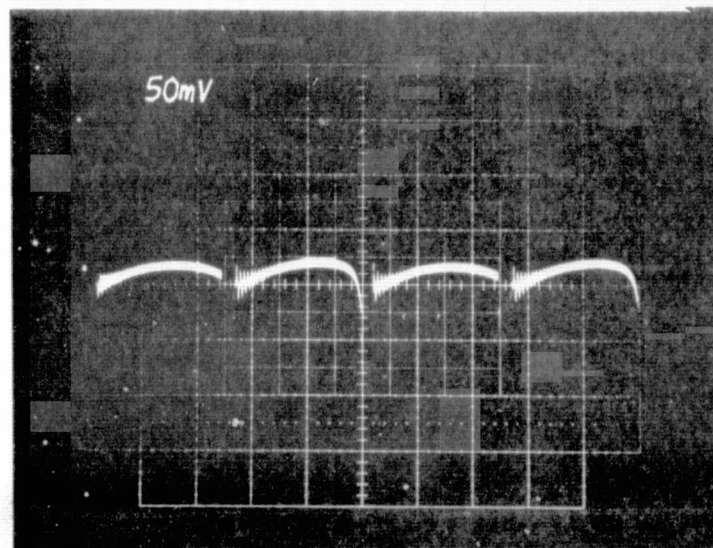


50mV/cm

10μS/cm

+5V. Ripple Voltage

4.8.7



50mV/cm

10μS/cm

+20V. Ripple Voltage



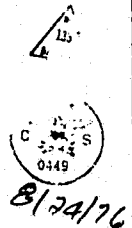
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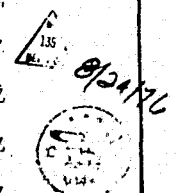
## 4.11.3,4,5,6 Nominal Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 18.697 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 18.710 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 18.711 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 19.757 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 19.763 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 19.772 KHz          | 20 KHz + 600 Hz |



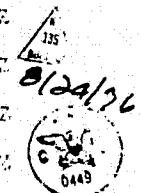
## 4.11.7,8 -20°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 18.463 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 18.462 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 18.467 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 19.500 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 19.500 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 19.508 KHz          | 20 KHz + 600 Hz |



## 4.11.9,10 +50°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 18.771 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 18.768 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 18.773 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 19.823 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 19.816 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 19.821 KHz          | 20 KHz + 600 Hz |



Date Sheet 1

3.2

## SERIAL NUMBER

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- S/N 003
- Signature of Test Operator D J McDaniel
- Start of Test 5/10/76
- End of Test 5/14/76

3.3

## EQUIPMENT REQUIRED

- Temperature Chamber, Delta Designs Model 65451 or equivalent,  
N/A, S/N 1333
- Temperature Indicator, Minco Model 100A or equivalent,  
N/A, S/N 130, calibration due 8/10/76
- Oscilloscope and Camera, Tektronix 547 or equivalent,  
N/A, S/N B12820, calibration due 11/5/76
- Frequency Counter, HP5245L or equivalent N/A,  
S/N B13205765, calibration due 11/5/76
- DVM Plug In, HP5265A or equivalent N/A,  
S/N B13206912, calibration due 11/5/76
- Current Meter, Weston 911 or equivalent N/A,  
S/N B3217, calibration due 11/11/76
- Power Supply, HP6114A or equivalent N/A,  
S/N C-8742, calibration due 7/13/76
- Decade Resistor Box, GR-1432 M or equivalent N/A,  
S/N B1705061, calibration due 11/5/76
- Decade Resistor Box, GR-1432 M or equivalent N/A,  
S/N 3132, calibration due 6/18/76
- VOM, Simpson 260 or equivalent HP 3465A,  
S/N C-9130, calibration due 11/10/76



## Data Sheet 2

|       |                                                  |                                           |
|-------|--------------------------------------------------|-------------------------------------------|
| 3.5.2 | Power Supply Current.                            | Check <input checked="" type="checkbox"/> |
| 4.1   | Visual Inspection.                               | Check <input checked="" type="checkbox"/> |
| 4.4.1 | EQ1 (2N4858) Gate Voltage<br>S/N <u>130</u>      | <u>0.530</u> V.                           |
| 4.4.2 | R1 = EQ1 x 100 $\frac{\text{ohms}}{\text{volt}}$ | <u>53</u>                                 |
| 4.5.2 | R1 Selection<br>Record R1 Setting.               | <u>71</u>                                 |
|       | Record Nearest 5% Value.                         | <u>68</u>                                 |
| 4.5.3 | R3 Selection<br>Record R3 Setting.               | <u>741</u>                                |
|       | Record Nearest 1% Standard Value                 | <u>750</u>                                |
| 4.5.7 | Record Frequency<br><u>Measured</u>              | Reference<br>only                         |
|       | <u>20002</u> kHz                                 |                                           |
| 4.5.9 | R2 Selection<br>Record R2 setting                | <u>195 <math>\Omega</math></u>            |
|       | Record nearest 1% standard value                 | <u>196 <math>\Omega</math></u>            |
| 4.6.1 | No Load Input Current<br><u>Measured</u>         | Requirement<br>25 $\pm$ 15 mA.            |
|       | <u>25.2</u> mA.                                  |                                           |
| 4.6.6 | Full Load Input Current<br><u>Measured</u>       | Requirement<br>150 $\pm$ 20 mA.           |
|       | <u>160.6</u> mA.                                 |                                           |
| 4.7.1 | Gen. Voltage<br><u>Measured</u>                  | Requirement<br>20 $\pm$ 2 V.              |
|       | <u>20.138</u> V.                                 |                                           |

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## Data Sheet 2 (Continued)

|        |                         |                    |
|--------|-------------------------|--------------------|
| 4.7.2  | +5 Volt Measurement     |                    |
|        | <u>Measurement</u>      | <u>Requirement</u> |
|        | <u>5.123</u> V.         | 5.6 ± 1.0 V.       |
| 4.7.3  | +20 Volt Measurement    |                    |
|        | <u>Measurement</u>      | <u>Requirement</u> |
|        | <u>20.557</u> V.        | 20 ± 2.0 V.        |
| 4.8.5  | +5V Ripple Measurement  |                    |
|        | <u>Measurement</u>      | <u>Requirement</u> |
|        | <u>.025</u> V. Pk - Pk  | ≤ 0.05 V. Pk Pk    |
| 4.8.7  | +20V Ripple Measurement |                    |
|        | <u>Measurement</u>      | <u>Requirement</u> |
|        | <u>.025</u> V. Pk - Pk  | ≤ 0.25 V. Pk Pk    |
| 4.9.1  | Fast Turn-On Check      |                    |
|        |                         | <u>OK</u> Check    |
| 4.10.2 | Isolation Resistance    |                    |
|        | <u>Measurement</u>      | <u>Requirement</u> |
|        | <u>21</u> MΩ            | > 1MΩ              |

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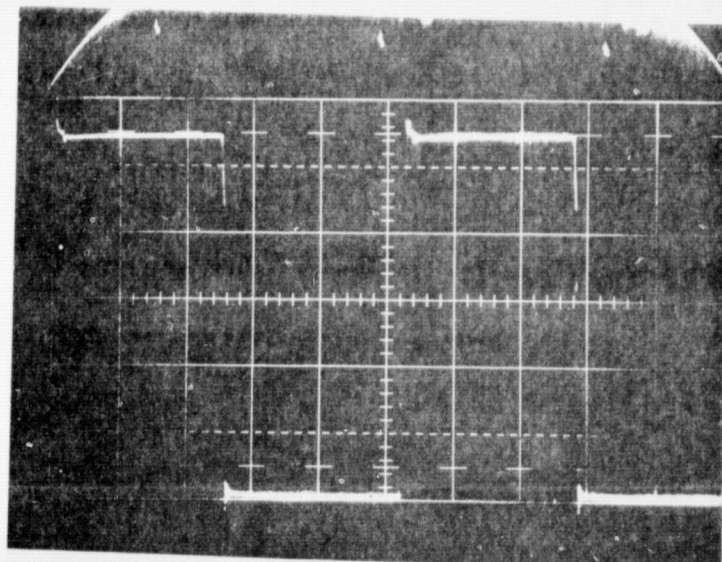
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REV

Data Sheet 3

4.8.2

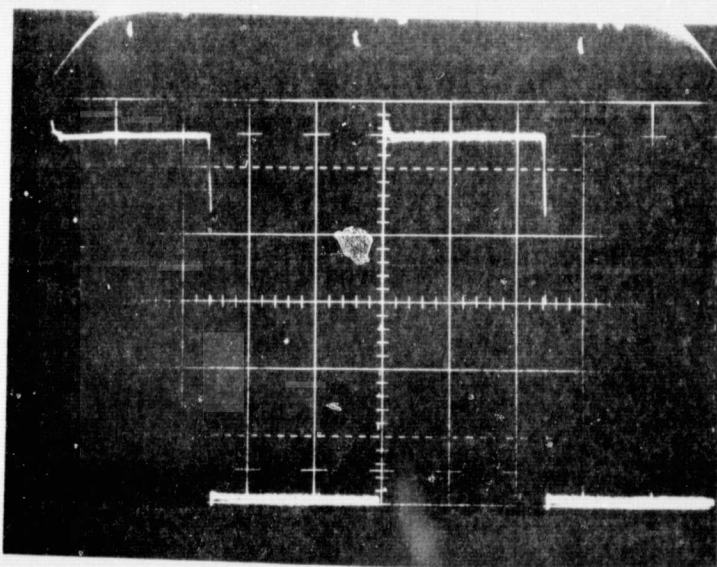


10V/cm

10uS/cm

19KHz Switching Wave Shape

4.8.3



10V/cm

10uS/cm

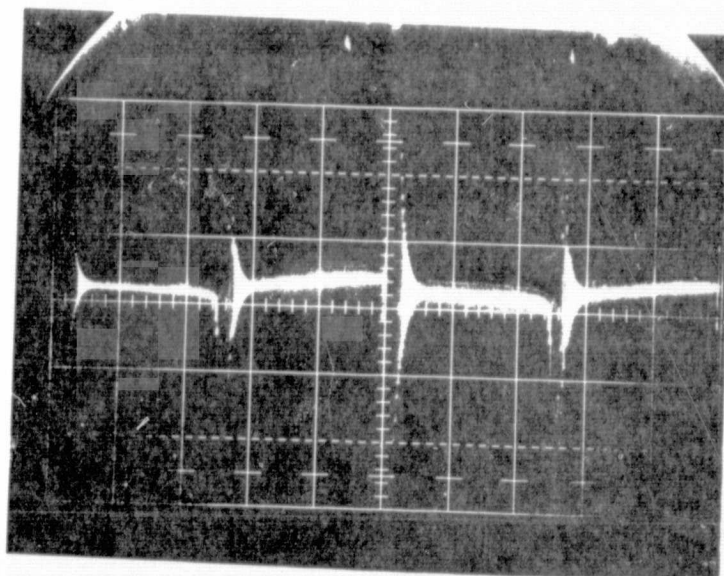
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20KHz Switching Wave Shape



Data Sheet 4

4.8.5

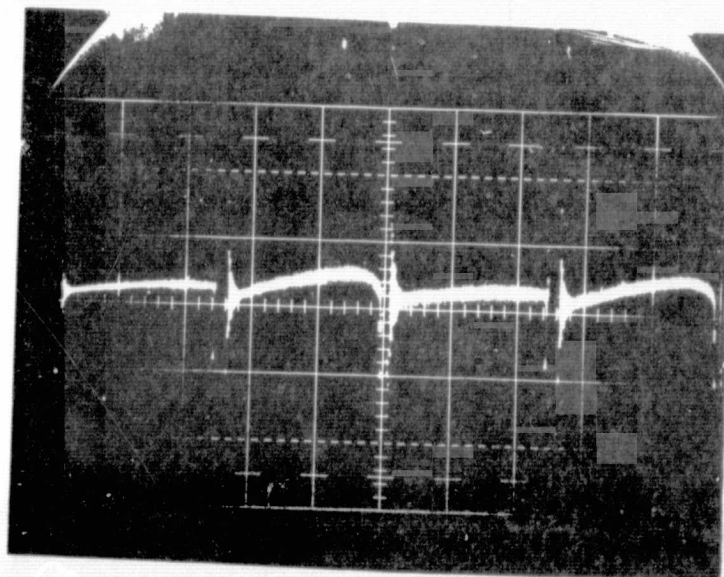


50mV/cm

10nS/cm

+5V. Ripple Voltage

4.8.7



50mV/cm

10nS/cm

+20V. Ripple Voltage

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Data Sheet 5

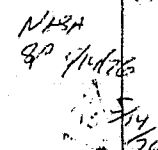
4.11.3,4,5,6 Nominal Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 19.020 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 19.010 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 19.007 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 20.024 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 20.010 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 20.024 KHz          | 20 KHz + 600 Hz |



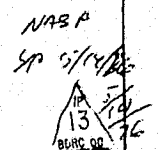
4.11.7,8 -20°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 18.780 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 18.833 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 18.836 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 19.823 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 19.842 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 19.843 KHz          | 20 KHz + 600 Hz |



4.11.9,10 +50°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | 19.057 KHz          | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | 19.068 KHz          | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | 19.073 KHz          | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | 20.091 KHz          | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | 20.080 KHz          | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | 20.086 KHz          | 20 KHz + 600 Hz |



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Date Sheet 1

3.2 SERIAL NUMBER

- S/N 005
- Signature of Test Operator W. L. McDaniel
- Start of Test 5/11/76
- End of Test 5/14/76

3.3 EQUIPMENT REQUIRED

- Temperature Chamber, Delta Designs Model 6545L or equivalent, N/A, S/N 1333.
- Temperature Indicator, Minco Model 100A or equivalent, N/A, S/N 130, calibration due 8/10/76.
- Oscilloscope and Camera, Tektronix 547 or equivalent, N/A, S/N B12820, calibration due 11/5/74.
- Frequency Counter, HP5245L or equivalent N/A, S/N B32C 5765, calibration due 11/5/74.
- DVM Plug In, HP5265A or equivalent N/A, S/N B32C 6912, calibration due 11/5/74.
- Current Meter, Weston 911 or equivalent N/A, S/N B-3217, calibration due 11/11/74.
- Power Supply, HP6114A or equivalent N/A, S/N C-8792, calibration due 7/13/76.
- Decade Resistor Box, GR-1432-M or equivalent N/A, S/N B32C 5061, calibration due 11/5/74.
- Decade Resistor Box, GR-1432-M or equivalent N/A, S/N 3132, calibration due 6/18/76.
- VOM, Simpson 260 or equivalent HP 3465A, S/N 0-9130, calibration due 11/10/76.

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## Data Sheet 2

|       |                                                                |                                    |
|-------|----------------------------------------------------------------|------------------------------------|
| 3.5.2 | Power Supply Current.                                          | Check <u>✓</u>                     |
| 4.1   | Visual Inspection.                                             | Check <u>✓</u>                     |
| 4.4.1 | EQ1 (2N4858) Gate Voltage<br>S/N <u>128</u>                    | <u>0.234</u> V.                    |
| 4.4.2 | R1 = EQ1 x 100 $\frac{\text{ohms}}{\text{volt}}$               | <u>23.4</u> $\Omega$               |
| 4.5.2 | R1 Selection<br>Record R1 Setting.                             | <u>41.5</u> $\Omega$               |
|       | Record Nearest 5% Value.                                       | <u>43</u> $\Omega$                 |
| 4.5.3 | R3 Selection<br>Record R3 Setting.                             | <u>714</u> $\Omega$                |
|       | Record Nearest 1% Standard Value                               | <u>715</u> $\Omega$                |
| 4.5.7 | Record Frequency<br><u>Measured</u><br><u>20.03</u> kHz        | Reference<br>Only                  |
| 4.5.9 | R2 Selection<br>Record R2 setting                              | <u>201</u>                         |
|       | Record nearest 1% standard value                               | <u>200</u> $\Omega$                |
| 4.6.1 | No-Load Input Current<br><u>Measured</u><br><u>23.0</u> mA.    | <u>Requirement</u><br>25 + 15 mA.  |
| 4.6.6 | Full-Load Input Current<br><u>Measured</u><br><u>158.5</u> mA. | <u>Requirement</u><br>160 + 20 mA. |
| 4.7.1 | Zener Voltage<br><u>Measured</u><br><u>20.181</u> V.           | <u>Requirement</u><br>20 + 2 V.    |



## Data Sheet 2 (Continued)

|        |                                               |                        |
|--------|-----------------------------------------------|------------------------|
| 4.7.2  | +5 Volt Measurement                           |                        |
|        | <u>Measurement</u>                            | <u>Requirement</u>     |
|        | <u>5.108</u> V.                               | 5.6 $\pm$ 1.0 V.       |
| 4.7.3  | +20 Volt Measurement                          |                        |
|        | <u>Measurement</u>                            | <u>Requirement</u>     |
|        | <u>20.572</u> V.                              | 20 $\pm$ 2.0 V.        |
| 4.8.5  | +5V Ripple Measurement                        |                        |
|        | <u>Measurement</u>                            | <u>Requirement</u>     |
|        | <u>.035</u> V. Pk - Pk                        | $\leq$ 0.05 V. Pk - Pk |
| 4.8.7  | +20V Ripple Measurement                       |                        |
|        | <u>Measurement</u>                            | <u>Requirement</u>     |
|        | <u>.030</u> V. Pk - Pk                        | $\leq$ 0.25 V. Pk - Pk |
| 4.9.1  | Fast Turn-On Check                            |                        |
|        |                                               | <u>OK</u> Check        |
| 4.10.2 | Isolation Resistance                          |                        |
|        | <u>Measurement</u>                            | <u>Requirement</u>     |
|        | <u>&gt; 1</u> <sup>M<math>\Omega</math></sup> | $\geq$ 1M $\Omega$     |





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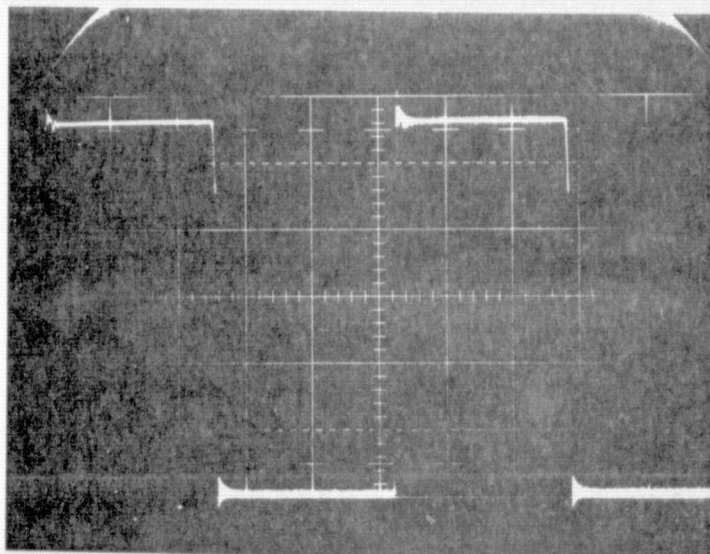
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SHEET 19

REV

### Data Sheet 3:

4.8.2



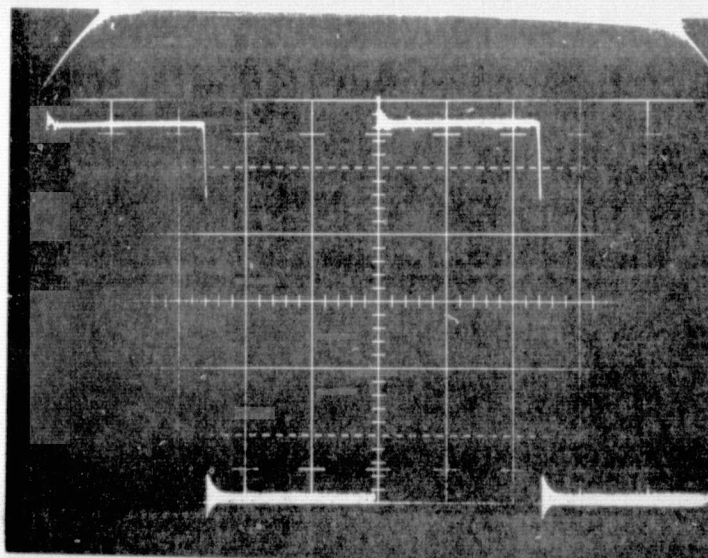
10V/cm

10μS/cm

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19KHz Switching Wave Shape

4.8.3



10V/cm

10μS/cm

20KHz Switching Wave Shape



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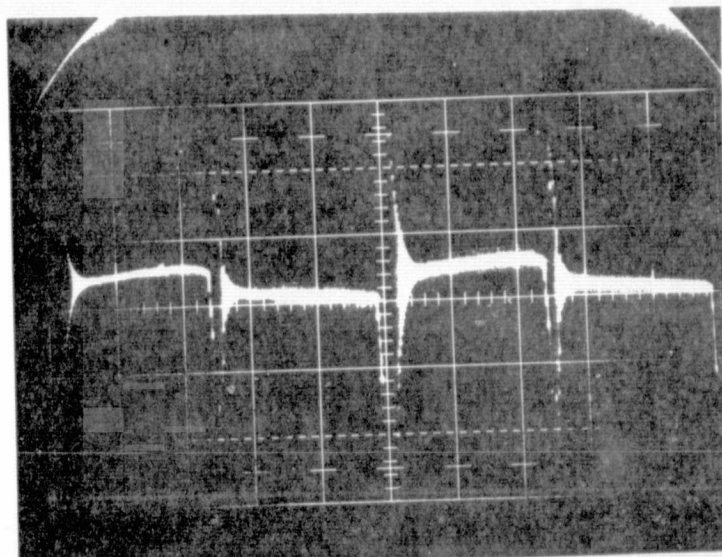
REV

DOC NO

DATE

# Data Sheet 4

4.8.5

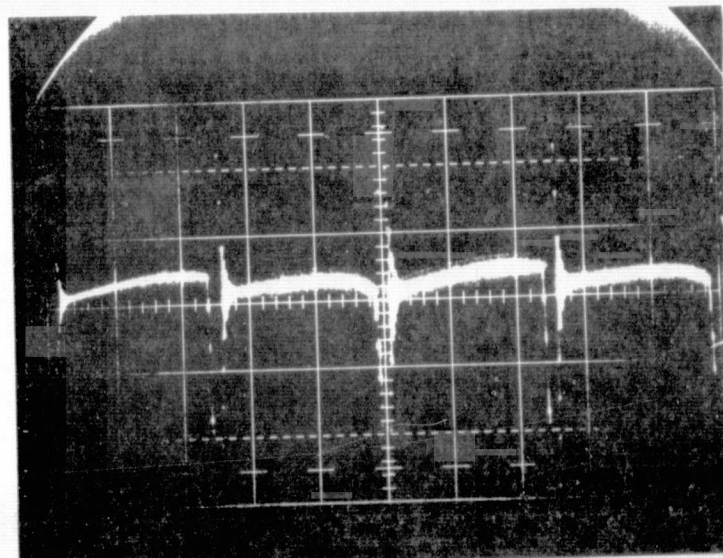


50mV/cm

10 $\mu$ S/cm

+5V. Ripple Voltage

4.8.7



50mV/cm

10 $\mu$ S/cm

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+20V. Ripple Voltage

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CODE IDENT NO 13993

SHEET 21

REV

## Data Sheet 5

## 4.11.3,4,5,6 Nominal Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement                |
|----------------------|----------------------|---------------------|----------------------------|
| 28v + .01 volt       | 19 KHz               | <u>19.016</u> KHz   | <del>19 KHz</del> + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | <u>19.028</u> KHz   | 19 KHz + 570 Hz            |
| 28.56v + .01 volt    | 19 KHz               | <u>19.005</u> KHz   | 19 KHz + 570 Hz            |
| 28v + .01 volt       | 20 KHz               | <u>20.091</u> KHz   | 20 KHz + 600 Hz            |
| 27.44v + .01 volt    | 20 KHz               | <u>20.097</u> KHz   | 20 KHz + 600 Hz            |
| 28.56v + .01 volt    | 20 KHz               | <u>20.077</u> KHz   | 20 KHz + 600 Hz            |

5/4/76  
13  
BBRC OK

## 4.11.7,8 -20°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | <u>18.887</u> KHz   | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | <u>18.903</u> KHz   | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | <u>18.981</u> KHz   | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | <u>19.942</u> KHz   | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | <u>19.980</u> KHz   | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | <u>19.966</u> KHz   | 20 KHz + 600 Hz |

5/4/76  
13  
BBRC OK

## 4.11.9,10 +50°C Temperature

| Power Supply Setting | Freq. Switch Setting | Displayed Frequency | Requirement     |
|----------------------|----------------------|---------------------|-----------------|
| 28v + .01 volt       | 19 KHz               | <u>19.055</u> KHz   | 19 KHz + 570 Hz |
| 27.44v + .01 volt    | 19 KHz               | <u>19.075</u> KHz   | 19 KHz + 570 Hz |
| 28.56v + .01 volt    | 19 KHz               | <u>19.048</u> KHz   | 19 KHz + 570 Hz |
| 28v + .01 volt       | 20 KHz               | <u>20.111</u> KHz   | 20 KHz + 600 Hz |
| 27.44v + .01 volt    | 20 KHz               | <u>20.137</u> KHz   | 20 KHz + 600 Hz |
| 28.56v + .01 volt    | 20 KHz               | <u>20.115</u> KHz   | 20 KHz + 600 Hz |

5/4/76  
13  
BBRC OK





## Date Sheet 1

3.2

## SERIAL NUMBER

- S/N 006
- Signature of Test Operator D. L. McDaniel
- Start of Test 5/11/76
- End of Test 5/17/76

3.3

## EQUIPMENT REQUIRED

- Temperature Chamber, Delta Designs Model 6545L or equivalent, N/A, S/N 1333
- Temperature Indicator, Minco Model 100A or equivalent, N/A, S/N 130, calibration due 8/10/76
- Oscilloscope and Camera, Tektronix 547 or equivalent, N/A, S/N B-12820, calibration due 11/5/76
- Frequency Counter, HP5245L or equivalent N/A, S/N BBRC 5765, calibration due 11/5/76
- DVM Plug In, HP5265A or equivalent N/A, S/N BBRC 6912, calibration due 11/5/76
- Current Meter, Weston 911 or equivalent N/A, S/N B-3217, calibration due 11/11/76
- Power Supply, HP6114A or equivalent N/A, S/N C-8792, calibration due 7/13/76
- Decade Resistor Box, GR-1432-M or equivalent N/A, S/N BBRC 5061, calibration due 11/5/76
- Decade Resistor Box, GR-1432-M or equivalent N/A, S/N 3132, calibration due 6/18/76
- VOM, Simpson 260 or equivalent HP3465A, S/N C-9130, calibration due 11/10/76



## Data Sheet 2

|       |                                                              |                                 |
|-------|--------------------------------------------------------------|---------------------------------|
| 3.5.2 | Power Supply Current.                                        | Check <u>✓</u>                  |
| 4.1   | Visual Inspection.                                           | Check <u>✓</u>                  |
| 4.4.1 | EQ1 (2N4858) Gate Voltage<br>S/N <u>126</u>                  | <u>959</u> V.                   |
| 4.4.2 | R1 = EQ1 x 100 $\frac{\text{ohms}}{\text{volt}}$             | <u>95.9</u> $\Omega$            |
| 4.5.2 | R1 Selection<br>Record R1 Setting.                           | <u>114</u> $\Omega$             |
|       | Record Nearest 5% Value.                                     | <u>110</u> $\Omega$             |
| 4.5.3 | R3 Selection<br>Record R3 Setting.                           | <u>693</u> $\Omega$             |
|       | Record Nearest 1% Standard Value                             | <u>698</u> $\Omega$             |
| 4.5.7 | Record Frequency<br><u>Measured</u><br><u>24.005</u> kHz     | Reference<br>Only               |
| 4.5.9 | R2 Selection<br>Record R2 setting                            | <u>189</u> $\Omega$             |
|       | Record nearest 1% standard value                             | <u>187</u> $\Omega$             |
| 4.6.4 | No-Load Input Current<br><u>Measured</u><br><u>29.2</u> mA.  | Requirement<br>25 $\pm$ 15 mA.  |
| 4.6.5 | Full-Load Input Current<br><u>Measured</u><br><u>166</u> mA. | Requirement<br>160 $\pm$ 20 mA. |
| 4.7.1 | Zener Voltage<br><u>Measured</u><br><u>19.658</u> V.         | Requirement<br>20 $\pm$ 2 V.    |



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Data Sheet 2 (Continued)

|        |                          |                        |
|--------|--------------------------|------------------------|
| 4.7.2  | +5 Volt Measurement      |                        |
|        | <u>Measurement</u>       | <u>Requirement</u>     |
|        | <u>5.090</u> V.          | 5.6 $\pm$ 1.0 V.       |
| 4.7.3  | +20 Volt Measurement     |                        |
|        | <u>Measurement</u>       | <u>Requirement</u>     |
|        | <u>20.563</u> V.         | 20 $\pm$ 2.0 V.        |
| 4.8.5  | +5V Ripple Measurement   |                        |
|        | <u>Measurement</u>       | <u>Requirement</u>     |
|        | <u>0.030</u> V. Pk - Pk  | $\leq$ 0.05 V. Pk - Pk |
| 4.8.7  | +20V Ripple Measurement  |                        |
|        | <u>Measurement</u>       | <u>Requirement</u>     |
|        | <u>0.030</u> V. Pk - Pk  | $\leq$ 0.25 V. Pk - Pk |
| 4.9.1  | Fast Turn-On Check       |                        |
|        |                          | <u>OK</u> Check        |
| 4.10.2 | Isolation Resistance     |                        |
|        | <u>Measurement</u>       | <u>Requirement</u>     |
|        | <u>&gt; 1</u> M $\Omega$ | $>$ 1M $\Omega$        |





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DOC NO 10001

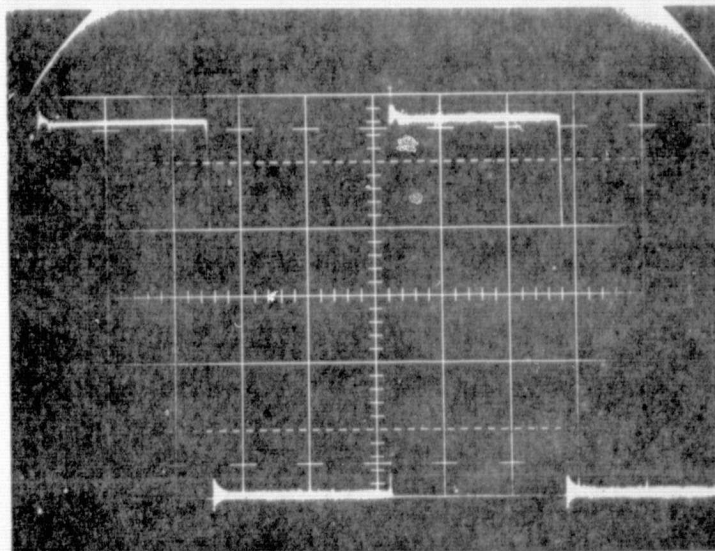
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REV

Data Sheet 3.

4.8.2



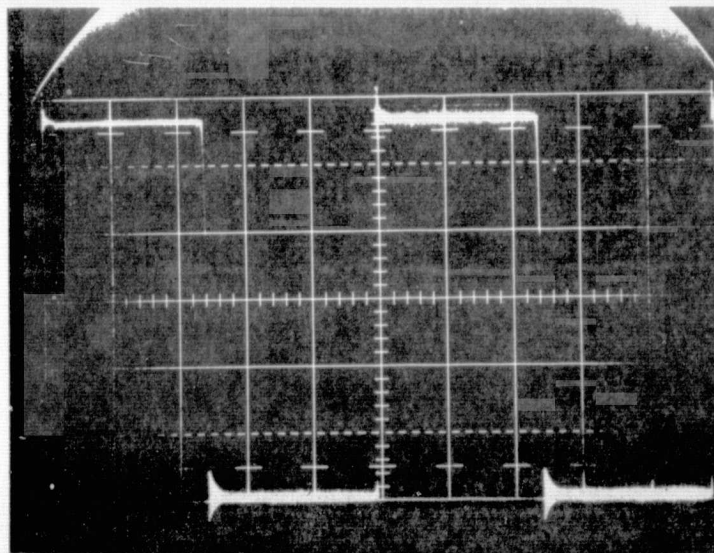
10V/cm

10μS/cm

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19KHz Switching Wave Shape

4.8.3



10V/cm

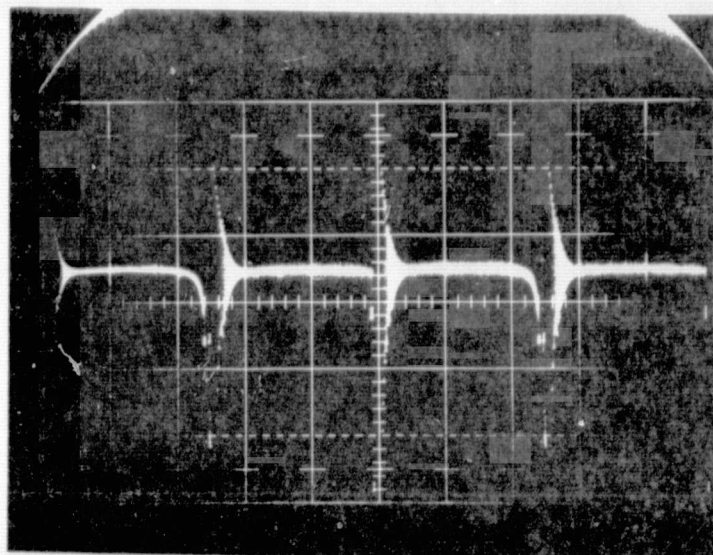
10μS/cm

20KHz Switching Wave Shape



Data Sheet 4

4.8.5



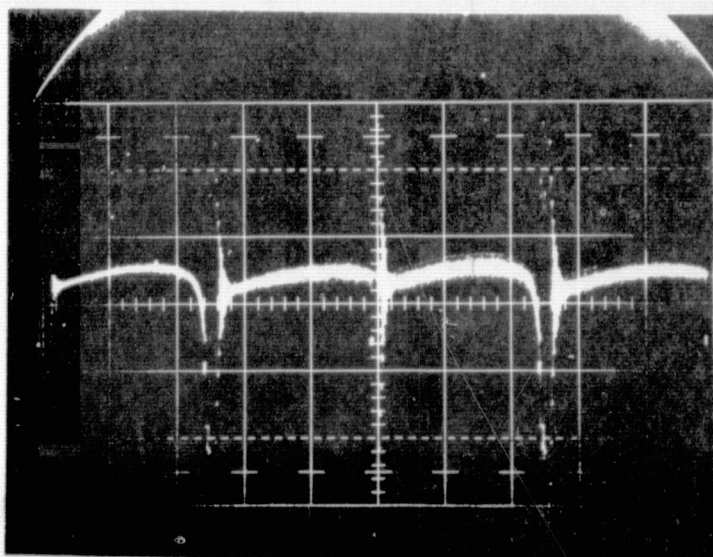
50mV/cm

10 $\mu$ S/cm

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+5V. Ripple Voltage

4.8.7



50mV/cm

10 $\mu$ S/cm

+20V. Ripple Voltage



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Data Sheet 5

4.11.3,4,5,6 Nominal Temperature

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| Power Supply<br>Setting | Freq. Switch<br>Setting | Displayed<br>Frequency | Requirement     |
|-------------------------|-------------------------|------------------------|-----------------|
| 28v + .01 volt          | 19 KHz                  | <u>19.032</u> KHz      | 19 KHz + 570 Hz |
| 27.44v + .01 volt       | 19 KHz                  | <u>19.028</u> KHz      | 19 KHz + 570 Hz |
| 28.56v + .01 volt       | 19 KHz                  | <u>19.038</u> KHz      | 19 KHz + 570 Hz |
| 28v + .01 volt          | 20 KHz                  | <u>20.059</u> KHz      | 20 KHz + 600 Hz |
| 27.44v + .01 volt       | 20 KHz                  | <u>20.047</u> KHz      | 20 KHz + 600 Hz |
| 28.56v + .01 volt       | 20 KHz                  | <u>20.054</u> KHz      | 20 KHz + 600 Hz |

4.11.7,8 -20°C Temperature

| Power Supply<br>Setting | Freq. Switch<br>Setting | Displayed<br>Frequency | Requirement     |
|-------------------------|-------------------------|------------------------|-----------------|
| 28v + .01 volt          | 19 KHz                  | <u>18.845</u> KHz      | 19 KHz + 570 Hz |
| 27.44v + .01 volt       | 19 KHz                  | <u>18.862</u> KHz      | 19 KHz + 570 Hz |
| 28.56v + .01 volt       | 19 KHz                  | <u>18.855</u> KHz      | 19 KHz + 570 Hz |
| 28v + .01 volt          | 20 KHz                  | <u>19.823</u> KHz      | 20 KHz + 600 Hz |
| 27.44v + .01 volt       | 20 KHz                  | <u>19.875</u> KHz      | 20 KHz + 600 Hz |
| 28.56v + .01 volt       | 20 KHz                  | <u>19.863</u> KHz      | 20 KHz + 600 Hz |

4.11.9,10 +50°C Temperature

| Power Supply<br>Setting | Freq. Switch<br>Setting | Displayed<br>Frequency | Requirement     |
|-------------------------|-------------------------|------------------------|-----------------|
| 28v + .01 volt          | 19 KHz                  | <u>19.131</u> KHz      | 19 KHz + 570 Hz |
| 27.44v + .01 volt       | 19 KHz                  | <u>19.116</u> KHz      | 19 KHz + 570 Hz |
| 28.56v + .01 volt       | 19 KHz                  | <u>19.104</u> KHz      | 19 KHz + 570 Hz |
| 28v + .01 volt          | 20 KHz                  | <u>20.136</u> KHz      | 20 KHz + 600 Hz |
| 27.44v + .01 volt       | 20 KHz                  | <u>20.118</u> KHz      | 20 KHz + 600 Hz |
| 28.56v + .01 volt       | 20 KHz                  | <u>20.119</u> KHz      | 20 KHz + 600 Hz |





APPENDIX D  
SUN STABILITY

**Ball Brothers Research Corporation**

SUBSIDIARY OF BALL CORPORATION

BOULDER COLORADO 80302

DOC NO \_\_\_\_\_

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 5 REV \_\_\_\_\_

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure Functional, Sun Stability-PAS, 51075.

## 3.2 GENERAL

- Serial Number 002
- Test Operator Signature D. L. McDaniel *imp* 2/1/76
- Date of Test 6/23/76  
7/1/76



## 3.3 EQUIPMENT REQUIRED

- Universal Timer-Counter, CMC 607A or equivalent N/A  
S/N B-6885, Cal Date AUG 20, 76
- Power Supply, HP6218A or equivalent 6114A  
S/N C-8792, Cal Date JUL 13, 76
- Decade Resistor Box, GR1432-M or equivalent D352  
S/N B-8429, Cal Date OCT 1, 76
- Pulse Generator, 3I Model PG-32 or equivalent N/A  
S/N B3RC 5754, Cal Date NOV 5, 76
- Oscilloscope with Camera, Tektronix 7623A or equivalent 7633A  
S/N C9002, Cal Date NOV 17, 76

4.1 Pulse DelayMeasured466  $\mu$  Sec.Requirement430 + 152  $\mu$  Sec.4.2 Stability MeasurementMeasured467  $\mu$  Sec.RequirementChange from previous step in  
2  $\mu$  Sec.

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DCC NO 51973

DATE

CODE IDENT NO 13993

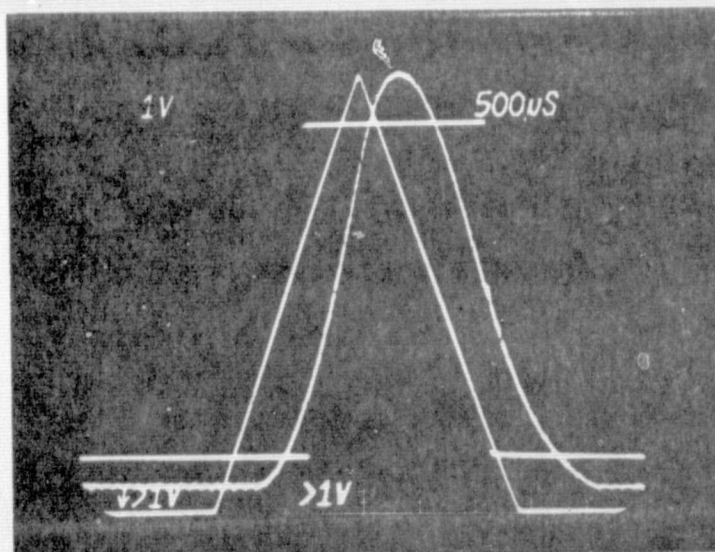
SHEET 10 REV

Data Sheet 2

4.2.3

4.2.3

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1 V/cm

500μs/cm

2 V/cm

Sun Slit Threshold

Falling Edge Threshold Amplitude

Measured

4.0 V.

Requirement

1/2 peak  $\pm$  0.5 V

Falling Edge Time Delay

Measured

420  $\mu$ s

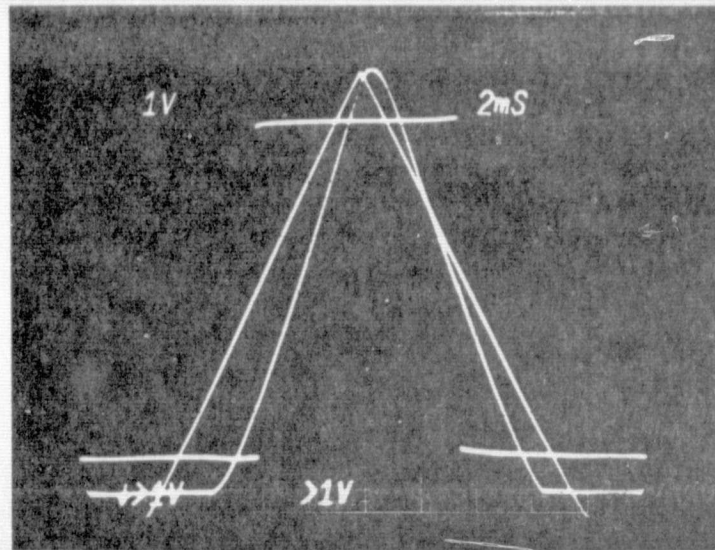
Reference Only





Data Sheet 5

4.2.4



1V/cm

5ms/cm

2V/cm

11/1/76

Threshold Stability

Falling Edge Threshold Stability

Measured

4.01 V

Requirement

Threshold of Paragraph  
4.2.3 + 1.6V (0.1%)

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**Ball Brothers Research Corporation**

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BOULDER, COLORADO 80302

DOC NO 51975

DATE

CODE IDENT NO 13993

SHEET 1

REV

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Functional, Sun Stability-PAS, 51975.

## 3.2 GENERAL

- Serial Number 003
- Test Operator Signature G. S. McDaniel
- Date of Test 7/19/76



## 3.3 EQUIPMENT REQUIRED

- Universal Timer-Counter, CMC 607A or equivalent N/A, S/N C-6885, Cal Date AUG 20, 76
- Power Supply, HP6218A or equivalent 2005A, S/N B12146, Cal Date DEC 29, 1976
- Decade Resistor Box, GR1432-M or equivalent N/A, S/N 3132, Cal Date JAN 2, 1977
- Pulse Generator, 3I Model PG-32 or equivalent N/A, S/N BBPC 5756, Cal Date NOV 5, 76
- Oscilloscope with Camera, Tektronix 7623A or equivalent 7633, S/N C-9002, Cal Date NOV 17, 76

4.1.2 Pulse DelayMeasured465  $\mu$  Sec.Requirement436  $\pm$  132  $\mu$  Sec.4.1.3 Stability MeasurementMeasured463  $\mu$  Sec.RequirementChange from previous step must be  
 $\leq 2 \mu$  Sec.



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DOC NO 51975

DATE

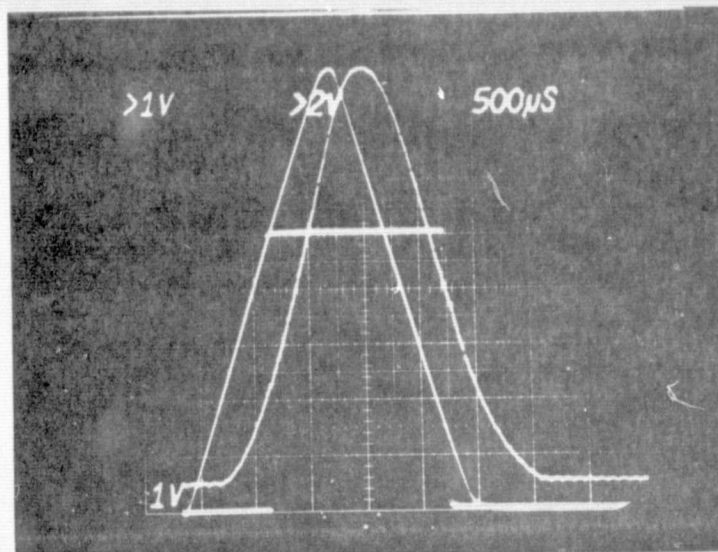
CODE IDENT NO 13993

SHEET 10 REV

Data Sheet 2

4.2.3

4.2.3



1 V/cm

500μs/cm

2 V/cm

Sun Slit Threshold

ORIGINAL PAGE IS  
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Falling Edge Threshold Amplitude

Measured

4.0 V.

Requirement

1/2 peak + 0.5 V

Falling Edge Time Delay

Measured

*adm.*  
*7/20/76* 400  
2.0 μs

Reference Only





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DOC NO 51975

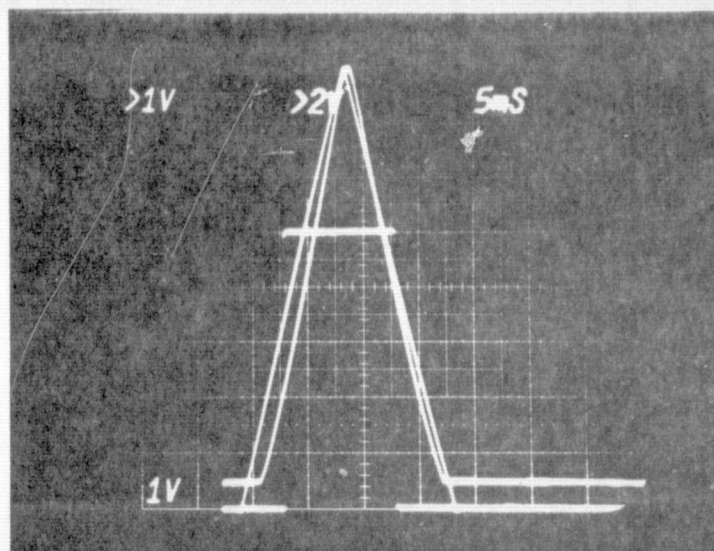
DATE

CODE IDENT NO 13993

SHEET 11 REV

### Data Sheet 3

4.2.4



1V/cm

5ms/cm

2V/cm

### Threshold Stability

### Falling Edge Threshold Stability

Measured

4.0 V.

Requirement

Threshold of Paragraph  
4.2.3  $\pm$  1.6V (0.1°)



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BOULDER, COLORADO 80302

DOC NO 51975

DATE

CODE IDENT NO 13993

SHEET 9 REV

Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Functional, Sun Stability-PAS, 51975.

3.2 GENERAL

- Serial Number 004
- Test Operator Signature D. L. McDaniel
- Date of Test 7/16/76

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3.3 EQUIPMENT REQUIRED

- Universal Timer-Counter, CMC 607A or equivalent N/A,  
S/N BB2C 6805, Cal Date AUG 20, 76
- Power Supply, HP6218A or equivalent HP 6114A 2005A,  
S/N 812146, Cal Date DEC 29, 1976
- Decade Resistor Box, GR1432-M or equivalent DB52,  
S/N B-8429, Cal Date OCT 1, 76
- Pulse Generator, 3I Model PG-32 or equivalent TEK 2101,  
S/N 8226, Cal Date NOV 5, 76
- Oscilloscope with Camera, Tektronix 7623A or equivalent 7633B,  
S/N 19002, Cal Date NOV 17, 76

4.1.2 Pulse Delay

| Measured              | Requirement              |
|-----------------------|--------------------------|
| <u>412</u> $\mu$ Sec. | 436 $\pm$ 132 $\mu$ Sec. |

4.1.3 Stability Measurement

| Measured              | Requirement                                              |
|-----------------------|----------------------------------------------------------|
| <u>413</u> $\mu$ Sec. | Change from previous step must be<br>$\leq$ 2 $\mu$ Sec. |



7-16-76



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CODE IDENT NO 13993

DOC NO 51975

DATE

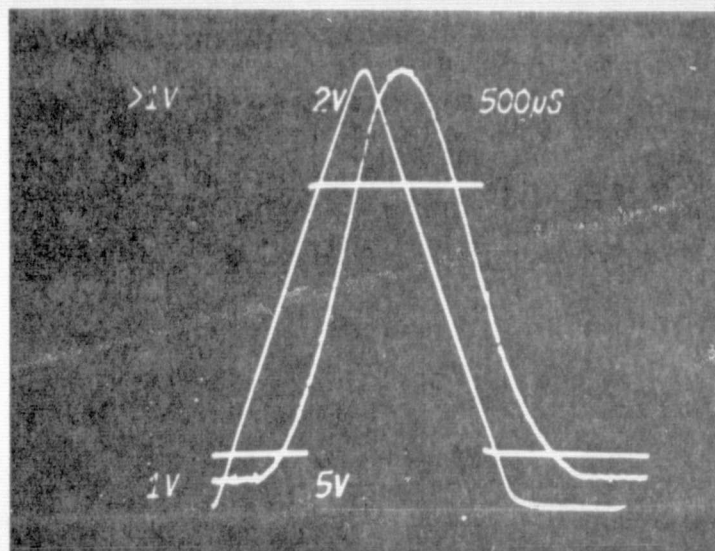
SHEET 10

REV

Data Sheet 2

4.2.3

4.2.3



1 V/cm

500  $\mu$ s/cm

2 V/cm

Sun Slit Threshold

Falling Edge Threshold Amplitude

Measured

4.0 V.

Requirement

1/2 peak + 0.5 V



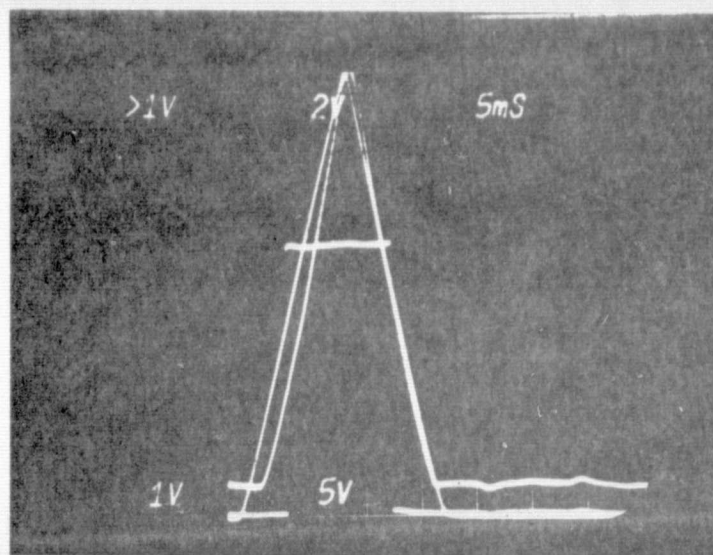
7-10-76





Data Sheet 3

4.2.4



Threshold Stability

Falling Edge Threshold Stability

Measured

4.0 V.

Requirement

Threshold of Paragraph  
4.2.3 + 1.6V (0.1°)

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7-10-76

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BOULDER, COLORADO 80302

DOC NO 51975

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 9 REV \_\_\_\_\_

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Functional, Sun Stability-PAS, 51975.

## 3.2 GENERAL

- Serial Number 005
- Test Operator Signature D. L. McDaniel
- Date of Test 10/25/76

## 3.3 EQUIPMENT REQUIRED

- Universal Timer-Counter, CMC 607A or equivalent N/A,  
S/N BBRC 6277, Cal Date MAR 3, 1977
- Power Supply, HP6218A or equivalent HP 6114A,  
S/N C-8792, Cal Date JAN 22, 1977
- Decade Resistor Box, GR1432-M or equivalent N/A,  
S/N BBRC 5464, Cal Date N/A
- Pulse Generator, 3I Model PG-32 or equivalent N/A,  
S/N BBRC 5756, Cal Date NOV 5, '76
- Oscilloscope with Camera, Tektronix 7623A or equivalent 7633,  
S/N C-9002, Cal Date NOV 17, 76

4.1.2 Pulse DelayMeasured362  $\mu$  Sec.Requirement436  $\pm$  132  $\mu$  Sec.4.1.3 Stability MeasurementMeasured362  $\mu$  Sec.Requirement

Change from previous step must be  
 $\leq 2 \mu$  Sec.



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DOC NO 51975

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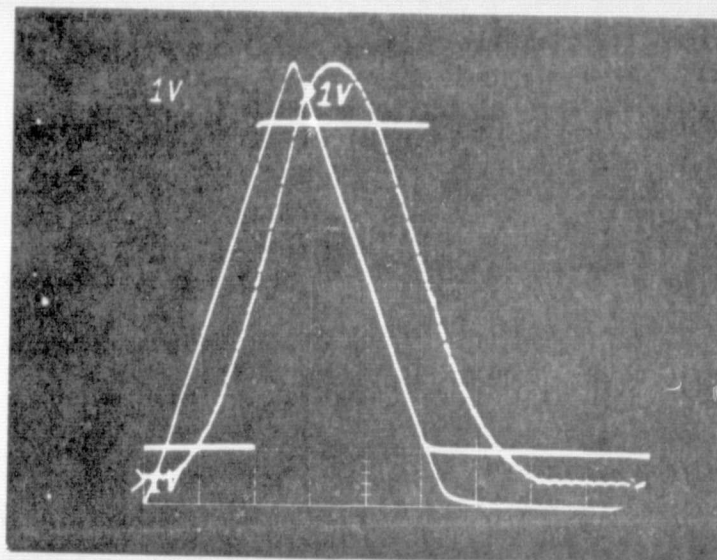
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SHEET 10 REV

Data Sheet 2

4.2.3

4.2.3



1 V/cm

500  $\mu$ s/cm

2 V/cm

Sun Slit Threshold

Falling Edge Threshold Amplitude

Measured

4.0 V.

Requirement

1/2 peak  $\pm$  0.5 V

Falling Edge Time Delay

Measured

500  $\mu$ s

Reference Only





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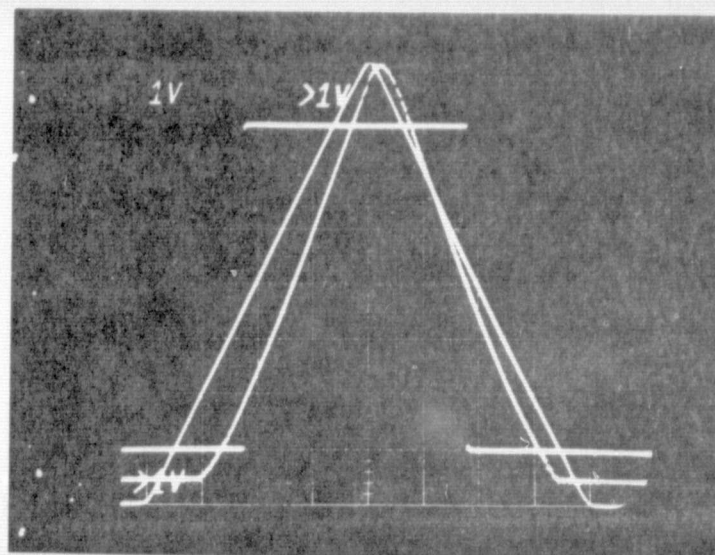
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SHEET 11

REV

### Data Sheet 3

4.2.4



1V/cm

5ms/cm

2V/cm

Threshold Stability

Falling Edge Threshold Stability

Measured

4.0 V.

Requirement

Threshold of Paragraph  
4.2.3  $\pm$  1.6V (0.1°)

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BOULDER, COLORADO 80302

DOC NO 51975

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 9

REV \_\_\_\_\_

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Functional, Sun Stability-PAS, 51975.

## 3.2 GENERAL

- Serial Number 006
- Test Operator Signature D. L. McDaniel
- Date of Test 10/25/76

## 3.3 EQUIPMENT REQUIRED

- Universal Timer-Counter, CMC 607A or equivalent N/A, S/N BBRC 6277, Cal Date MAR 3, '77
- Power Supply, HP6218A or equivalent HP 6114A, S/N CB792, Cal Date JAN 22, '77
- Decade Resistor Box, GRI432-M or equivalent N/A, S/N BBRC 5464, Cal Date N/A
- Pulse Generator, 3I Model PG-32 or equivalent N/A, S/N BBRC 5756, Cal Date NOV 3, '76
- Oscilloscope with Camera, Tektronix 7623A or equivalent 7633, S/N C-9002, Cal Date NOV 17, '76

4.1.2 Pulse Delay

| Measured              | Requirement              |
|-----------------------|--------------------------|
| <u>349</u> $\mu$ Sec. | 436 $\pm$ 132 $\mu$ Sec. |
| <del>434</del>        |                          |

4.1.3 Stability Measurement

| Measured              | Requirement                                         |
|-----------------------|-----------------------------------------------------|
| <u>348</u> $\mu$ Sec. | Change from previous step must be $\leq 2 \mu$ Sec. |



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DOC NO 51975

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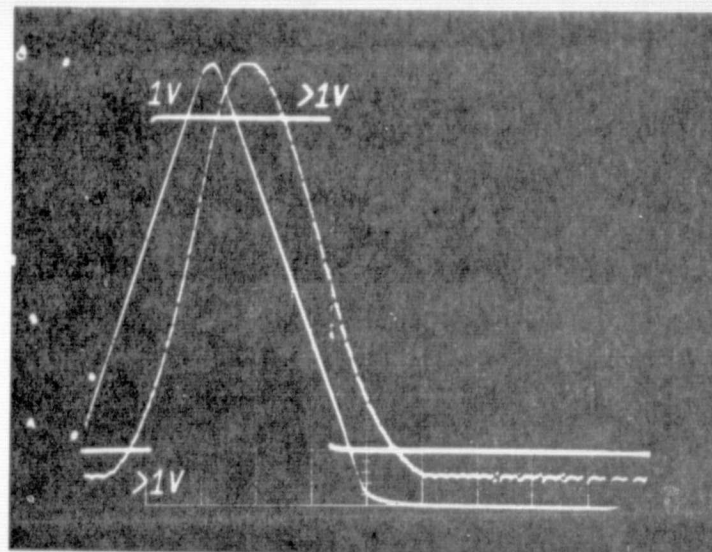
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SHEET 10 REV

Data Sheet 2

4.2.3

4.2.3



1 V/cm

500  $\mu$ s/cm

2 V/cm

Sun Slit Threshold

Falling Edge Threshold Amplitude

Measured

4.0 V.

350  $\mu$ sec

Requirement

1/2 peak  $\pm$  0.5 V

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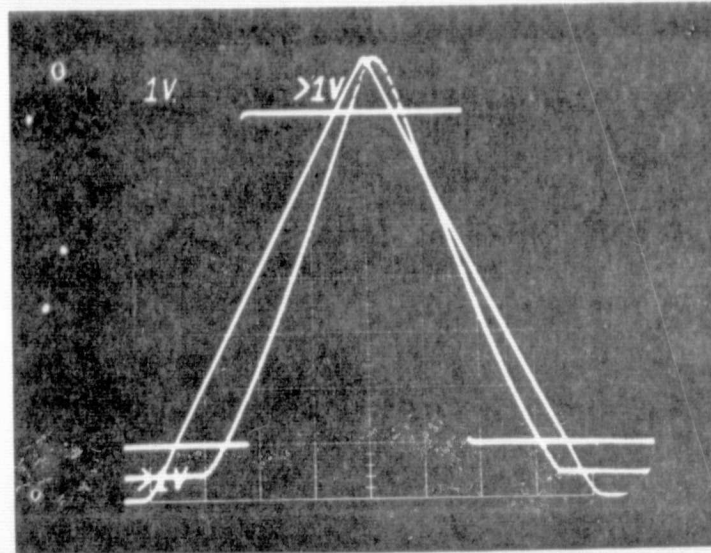
DATE

CODE IDENT NO 13993

SHEET 11 REV

Data Sheet 3

4.2.4



Threshold Stability

Falling Edge Threshold Stability

Measured

4.0 V.

Requirement

Threshold of Paragraph  
4.2.3  $\pm$  1.6V (0.1°)



APPENDIX E  
MECHANICAL DIMENSIONS

**Ball Brothers Research Corporation**

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BOULDER, COLORADO 80302

DOC NO 49961

DATE

19

REV

CODE IDENT NO 13993

SHEET

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure 49961.

## 3.8 SERIAL NUMBER

- Scanner head serial number \_\_\_\_\_.
- Main Electronics serial number 002.

## 3.9 TEST OPERATOR

- Signature of test operator Paul A. Crews
- Date of start of test 6-25-76.
- Date of End of test 6-25-76.

4.1.1 Dimensional Measurements

## Instrument Assembly (Figure 2)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>        |
|------------------|-----------------|----------------------|
| A                | 3.470           | <u>3.4600</u> inches |
|                  | 3.450           |                      |
| B                | 3.010           | <u>2.9994</u> inches |
|                  | 2.990           |                      |
| C                | 3.093 Basic     | <u>3.0921</u>        |
|                  |                 | <u>3.0933</u> inches |
| D                | 2.625 Basic     | <u>2.6245</u>        |
|                  |                 | <u>2.6252</u> inches |
| E                | .187 Basic      | <u>.1880</u>         |
|                  |                 | <u>.1880</u> inches  |
| F                | .183 Basic      | <u>.1832</u>         |
|                  |                 | <u>.1825</u> inches  |
| G                | .175            | <u>.1801</u> inches  |
|                  | .183            |                      |
| H                | .005            | <u>.0018</u> inches  |

+ .005 Hole size over  
Low  
@ .010 Allowance



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DOC NO 49961

DATE

CODE IDENT NO 13993

SHEET 20

REV

Data Sheet 1 (con't)

J 3.90 Maximum 3.9226 inches

K .135  
.115 .1277 .1301  
.1286 .1285 inches

L .002 Maximum .0011 inches

*gms witness only.*  
*DCA*

*SEE*  
*WOR #A3190*



Data Sheet 2

S/N 002 (BOX)  
WEB

4.1.1 Dimensional Measurements

Electronics Assembly (Figure 3)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>        |
|------------------|-----------------|----------------------|
| A                | 6.195<br>6.175  | <u>6.187</u> inches  |
| B                | 6.025<br>6.030  | <u>6.018</u> inches  |
| C                | 5.847 Basic     | <u>5.8475</u> inches |
| D                | 5.295<br>5.285  | <u>5.285</u> inches  |
| E                | 46°<br>44°      | <u>45°</u> inches    |
| F                | .469<br>.479    | <u>.460</u> inches   |
| G                | .169 Basic      | <u>.170</u> inches   |
| H                | .085<br>.075    | <u>.082</u> inches   |
| J                | 8.135<br>8.115  | <u>8.126</u> inches  |
| K                | 7.965<br>7.970  | <u>7.962</u> inches  |
| L                | 7.787 Basic     | <u>7.786</u> inches  |
| M                | .185<br>.193    | <u>.189</u> inches   |

See  
N012  
A30190  
#30190





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DOC NO \_\_\_\_\_

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 23 REV \_\_\_\_\_

## Data Sheet 2 (cont'd)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>       |
|------------------|-----------------|---------------------|
| N                | .010            | <u>.003</u> inches  |
| P                | .005            | <u>.002</u> inches  |
| Q                | .094<br>.099    | <u>.096</u> inches  |
| R                | 1.360<br>1.340  | <u>1.349</u> inches |
| S                | .087<br>.092    | <u>.087</u> inches  |
| T                | .005            | <u>.002</u> inches  |
| U                | 7.960<br>7.955  | <u>7.958</u> inches |
| V                | 46°<br>44°      | <u>45°</u> inches   |
| Y                | .462<br>.472    | <u>.465</u> inches  |
| Z                | .075<br>.085    | <u>.084</u> inches  |
| AA               | .169 Basic      | <u>.171</u> inches  |
| AB               | .085<br>.075    | <u>.079</u> inches  |
| AC               | .077<br>.087    | <u>.078</u> inches  |

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DOC NO 49961

DATE

25

REV

CODE IDENT NO 13993

SHEET

002

## Data Sheet 3

4.1.2 Weight Measurement

## Instrument Assembly (Head)

Required

&lt;499 gms.

Actual567.90 gm.

7-28-76



Two 28 Jul 76

REF.

## Electronics Assembly

&lt;998 gms.

1,110.00 gm.

7-28-76



Two 28 Jul 76

WDR #  
A300954.1.3 Center of Gravity Measurement

## Instrument Assembly (Figure 2)

N 1.687 inchesP 1.657 inchesM 1.434 inches

## Electronics Assembly (Figure 3)

AD 4.048 inchesAE 3.056 inchesAF 0.690 inches

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DOC NO \_\_\_\_\_

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 19 REV \_\_\_\_\_

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure 49961.

## 3.8 SERIAL NUMBER

- Scanner head serial number 003.
- Main Electronics serial number 003.

## 3.9 TEST OPERATOR

- Signature of test operator Paul A. Creas *T. unit*
- Date of start of test 8-11-76.
- Date of End of test 8-11-76.

4.1.1 Dimensional Measurements

## Instrument Assembly (Figure 2)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>                  |
|------------------|-----------------|--------------------------------|
| A                | 3.470<br>3.450  | <u>3.4608</u> inches           |
| B                | 3.010<br>2.990  | <u>3.0064</u> inches           |
| C                | 3.093 Basic     | $\frac{3.0928}{3.0913}$ inches |
| D                | 2.625 Basic     | $\frac{2.6242}{2.6239}$ inches |
| E                | .187 Basic      | $\frac{.189}{.1864}$ inches    |
| F                | .183 Basic      | $\frac{.1844}{.1838}$ inches   |
| G                | .175<br>.183    | <u>.1803</u> inches            |
| H                | .005            | <u>.004</u> inches             |



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DOC NO 49901

DATE       

CODE IDENT NO 13993

SHEET 20 REV       

Data Sheet 1 (con't)

|   |                         |                                                |
|---|-------------------------|------------------------------------------------|
| J | 3.90 Maximum            | <u>3.9173</u> inches                           |
| K | <del>.135</del><br>.115 | <del><u>.1287</u></del><br><u>.1283</u> inches |
| L | .002 Maximum            | <u>.0014</u> inches                            |

MD2A3-297  
3/11/76



## Data Sheet 2

4.1.1 Dimensional Measurements

## Electronics Assembly (Figure 3)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>                         |
|------------------|-----------------|---------------------------------------|
| A                | 6.195<br>6.175  | <u>6.188</u> inches                   |
| B                | 6.025<br>6.030  | <u>6.0324</u><br><u>6.0290</u> inches |
| C                | 5.847 Basic     | <u>5.8470</u> inches                  |
| D                | 5.295<br>5.285  | <u>5.2984</u><br><u>5.295</u> inches  |
| E                | 46°<br>44°      | <u>45°</u> inches                     |
| F                | .469<br>.479    | <u>.444</u><br><u>.450</u> inches     |
| G                | .169 Basic      | <u>.1697</u><br><u>.1709</u> inches   |
| H                | .085<br>.075    | <u>.0791</u><br><u>.0782</u> inches   |
| J                | 8.135<br>8.115  | <u>8.126</u> inches                   |
| K                | 7.965<br>7.970  | <u>7.970</u><br><u>7.966</u> inches   |
| L                | 7.787 Basic     | <u>7.7863</u><br><u>7.7856</u> inches |
| M                | .185<br>.193    | <u>.1890</u> inches                   |

MDR A30297  
8-11-76MDR  
A30297  
8-11-76MDR  
A30297  
8-11-76



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BOULDER COLORADO 80302

DOC NO 19961

DATE

CODE IDENT NO 13993

SHEET 22 REV

**Data Sheet 2 (cont'd)**

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>               |
|------------------|-----------------|-----------------------------|
| N                | .010            | <u>.002</u> inches          |
| P                | .005            | <u>.003</u> inches          |
| Q                | .094<br>.099    | <u>.097</u> inches          |
| R                | 1.360<br>1.340  | <u>1.354</u> inches         |
| S                | .087<br>.092    | <u>.0942 / .0897</u> inches |
| T                | .005            | <u>.002</u> inches          |
| U                | 7.960<br>7.955  | <u>7.9575</u> inches        |
| V                | 46°<br>44°      | <u>45°</u> inches           |
| Y                | .462<br>.472    | <u>.466 / .472</u> inches   |
| Z                | .075<br>.085    | <u>.0843</u> inches         |
| AA               | .169 Basic      | <u>.1699 / .1692</u> inches |
| AB               | .085<br>.075    | <u>.0798 / .0782</u> inches |
| AC               | .077<br>.087    | <u>.0848</u> inches         |
| W                |                 | <u>5.2442 / 5.2455</u>      |

MBZ  
A30297  
4  
5-11-76



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DATE

CODE IDENT NO 13993

SHEET

REV

### Data Sheet 3

#### 4.1.2 Weight Measurement

##### Instrument Assembly (Head)

Required

<499 gms.

Actual

569.5 gm.

*pac*

*SEE  
INDEX #A 30296*

##### Electronics Assembly

<998 gms.

1104.9 gm.

*pac*

#### 4.1.3 Center of Gravity Measurement

##### Instrument Assembly (Figure 2)

N 1.617 inches

P 1.677 inches

M 1.323 inches

*8-10-76*



##### Electronics Assembly (Figure 3)

AD 4.136 inches

AE 3.011 inches

AF .453 inches

*8-10-76*





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DOC NO 49961

DATE           

CODE IDENT NO 13993

SHEET 24 REV           

S/N 003

Data Sheet 4

4.4.3 Lower Heater Trip Point

Required

-10°C to -15°C

Actual

-13 °C

4.4.6 Upper Heater Trip Point

Required

-5°C to +5°C

Actual

-1 °C

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CODE IDENT NO 13993

SHEET

DOC NO 1961

DATE

19

REV

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure 19961.

## 3.8 SERIAL NUMBER

- Scanner head serial number 004
- Main Electronics serial number 004

## 3.9 TEST OPERATOR

- Signature of test operator Paul A. Crews
- Date of start of test July 23, 1976
- Date of End of test 8-6-76

4.1.1 Dimensional Measurements

Instrument Assembly (Figure 2)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>                                           |
|------------------|-----------------|---------------------------------------------------------|
| A                | 3.470<br>3.450  | $\frac{3.4611}{3.4619}$ inches                          |
| B                | 3.010<br>2.990  | $\frac{2.9987}{2.9985}$ inches                          |
| C                | 3.093 Basic     | $\frac{3.0925}{3.0921}$ inches                          |
| D                | 2.625 Basic     | $\frac{2.6248}{2.6243}$ inches                          |
| E                | .187 Basic      | $\frac{.189}{.188}$ inches                              |
| F                | .183 Basic      | $\frac{.1765}{.1746}$ inches                            |
| G                | .175<br>.183    | $\frac{.1799}{.1801}$ inches                            |
| H                | .005            | $\frac{.002 \text{ pattern}}{.012 \text{ Edge}}$ inches |

A 30193

See  
11/12  
A 30193



Ball Brothers Research Corporation

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DOC NO 49961

DATE

CODE IDENT NO 13993

SHEET 20 REV

Data Sheet 1 (con't)

|   |              |                                                                    |
|---|--------------|--------------------------------------------------------------------|
| J | 3.90 Maximum | <u>3.9152</u> inches                                               |
| K | .135<br>.115 | <u>.1283</u><br><u>.1288</u><br><u>.1292</u><br><u>.129</u> inches |
| L | .002 Maximum | <u>.0005</u> inches                                                |



See

Mo 2

A 30193



Data Sheet 2.

SN 004

4.1.1 Dimensional Measurements

Electronics Assembly (Figure 3)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>                         |
|------------------|-----------------|---------------------------------------|
| A                | 6.195<br>6.175  | <u>6.1875</u> inches                  |
| B                | 6.025<br>6.030  | <u>6.0331</u><br><u>6.0311</u> inches |
| C                | 5.847 Basic     | <u>5.8472</u><br><u>5.8476</u> inches |
| D                | 5.295<br>5.285  | <u>5.300</u><br><u>5.308</u> inches   |
| E                | 46°<br>44°      | <u>45°</u> inches                     |
| F                | .469<br>.479    | <u>.4338</u><br><u>.443</u> inches    |
| G                | .169 Basic      | <u>.1672</u><br><u>.1693</u> inches   |
| H                | .085<br>.075    | <u>.0795</u><br><u>.0775</u> inches   |
| J                | 8.135<br>8.115  | <u>8.1274</u> inches                  |
| K                | 7.965<br>7.970  | <u>7.970</u> inches                   |
| L                | 7.787 Basic     | <u>7.7876</u><br><u>7.7872</u> inches |
| M                | .185<br>.193    | <u>.1892</u> inches                   |

See WDR  
A30193

See WDR  
A30193

See WDR  
A30193





SUBSIDIARY OF BALL CORPORATION  
BOULDER, COLORADO 80302

CODE IDENT NO 13993

DATE 22 REV 22

Data Sheet 2 (cont'd)

S/N 004

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>                                       |
|------------------|-----------------|-----------------------------------------------------|
| N                | .010            | <u>.0036</u> inches                                 |
| P                | .005            | <u>.002</u> inches                                  |
| Q                | .094<br>.099    | <u>.0967</u><br><u>.0962</u> inches                 |
| R                | 1.360<br>1.340  | <u>1.3558</u> inches                                |
| S                | .087<br>.092    | <u>.0885</u><br><u>.0967</u><br><u>.0962</u> inches |
| T                | .005            | <u>.002</u> inches                                  |
| U                | 7.960<br>7.955  | <u>7.954</u> inches                                 |
| V                | 46°<br>44°      | <u>45°</u> inches <sup>SEE NOTE</sup> #A30143       |
| Y                | .462<br>.472    | <u>.4735</u><br><u>.4648</u> inches                 |
| Z                | .075<br>.085    | <u>.085</u> inches                                  |
| AA               | .169 Basic      | <u>.1687</u><br><u>.1671</u> inches                 |
| AB               | .085<br>.075    | <u>.0789</u> inches                                 |
| AC               | .077<br>.087    | <u>.0794</u> inches                                 |
| W                |                 | <u>5.2476</u><br><u>5.2544</u>                      |
| X                |                 | <u>6.0172</u>                                       |

PAC

7-15-74



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BOULDER, COLORADO 80302

DOC NO 49961

DATE 23

CODE IDENT NO 13993

SHEET 23

REV 004

### Data Sheet 3

#### 4.1.2 Weight Measurement

##### Instrument Assembly (Head)

Required

<499 gms.

Actual

566 gm.

##### Electronics Assembly

<998 gms.

1105.9 gm.

#### 4.1.3 Center of Gravity Measurement

##### Instrument Assembly (Figure 2)

N 1.677 inches

P 1.635 inches

M 1.414 inches

##### Electronics Assembly (Figure 3)

AD 4.009 inches

AE 3.083 inches

AF .594 inches



*See*

*7-28-76 MDR  
A30193*

*8-6-76*

*8-6-76*



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BOULDER, COLORADO 80302

DOC NO 49961

DATE           

CODE IDENT NO 13993

SHEET 24 REV           

*SN 004*

Data Sheet 4

4.4.3 Lower Heater Trip Point

Required

-10°C to -15°C

Actual

-12.5 °C

4.4.6 Upper Heater Trip Point

Required

-5°C to +5°C

Actual

+2 °C

**Ball Brothers Research Corporation**

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BOULDER COLORADO 80302

DOC NO 49961

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET \_\_\_\_\_

19

REV \_\_\_\_\_

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure 49961.

## 3.8 SERIAL NUMBER

- Scanner head serial number 005
- Main Electronics serial number 005

## 3.9 TEST OPERATOR

- Signature of test operator Paul A. Creutz
- Date of start of test Oct. 22, 1976
- Date of End of test ~~Nov~~ Dec. 2, 1976

4.1.1 Dimensional Measurements

## Instrument Assembly (Figure 2)

| <u>Dimension</u> | <u>Required</u>   | <u>Actual</u>        |
|------------------|-------------------|----------------------|
| A                | 3.470<br>3.450    | <u>3.462</u> inches  |
| B                | 3.010<br>2.990    | <u>3.0617</u> inches |
| C                | 3.093 Basic       | <u>3.0924</u> inches |
| D                | 2.625 Basic       | <u>2.6243</u> inches |
| E                | 187 Basic         | <u>.896</u> inches   |
| F                | .183 Basic        | <u>.1826</u> inches  |
| G                | .175<br>.183      | <u>.1783</u> inches  |
| H                | <u>.005, .008</u> | <u>.0042</u> inches  |

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BOULDER, COLORADO 80302

DOC NO 49961

DATE

20

REV A

CODE IDENT NO 13993

SHEET

Data Sheet 1 (con't)

|   |              |                           |
|---|--------------|---------------------------|
| J | 3.95 Maximum | <u>3.916</u> inches       |
| K | .135<br>.115 | <u>.1277/.1284</u> inches |
| L | .002 Maximum | <u>.00075</u> inches      |

*Fwt*  
*10/22/76*



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BOULDER, COLORADO 80302

DOC NO 49961

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 21 REV A

**Data Sheet 2.**

**4.1.1 Dimensional Measurements**

**Electronics Assembly (Figure 3)**

| <u>Dimension</u> | <u>Required</u>         | <u>Actual</u>             |
|------------------|-------------------------|---------------------------|
| A                | 6.195<br>6.175          | <u>6.1881</u> inches      |
| B                | 6.025<br>6.030          | <u>6.0292</u> inches      |
| C                | 5.847 Basic             | <u>5.8478</u> inches      |
| D                | 5.295<br>5.285          | <u>5.285</u> inches       |
| E                | 46°<br>44°              | <u>45°</u> degrees        |
| F                | .452<br><del>.442</del> | <u>.449</u> inches        |
| G                | .169 Basic              | <u>.168</u> inches        |
| H                | .085<br>.075            | <u>.0788</u> inches       |
| J                | 8.135<br>8.115          | <u>8.1271</u> inches      |
| K                | 7.965<br>7.970          | <u>7.9699</u> inches      |
| L                | 7.787 Basic             | <u>7.7876</u> inches      |
| M                | .185<br>.193            | <u>.186 / .189</u> inches |

Fail  
10/22/26



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BOULDER, COLORADO 80302

DOC NO 49961

DATE

CODE IDENT NO 13993

SHEET 22

REV A

**Data Sheet 2 (cont'd)**

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>        |
|------------------|-----------------|----------------------|
| N                | .010            | <u>.001</u> inches   |
| P                | .005            | <u>.003</u> inches   |
| Q                | .094<br>.099    | <u>.097</u> inches   |
| R                | 1.360<br>1.340  | <u>1.351</u> inches  |
| S                | .087<br>.092    | <u>.092</u> inches   |
| T                | .005            | <u>.003</u> inches   |
| U                | 7.960<br>7.955  | <u>7.9572</u> inches |
| V                | 46°<br>44°      | <u>45°</u> degrees   |
| W                | 5.245<br>5.255  | <u>5.250</u> inches  |
| X                | 6.015<br>6.020  | <u>6.018</u> inches  |
| Y                | .462<br>.472    | <u>.472</u> inches   |
| Z                | .075<br>.085    | <u>.085</u> inches   |
| AA               | .169 Basic      | <u>.167</u> inches   |
| AB               | .085<br>.075    | <u>.0785</u> inches  |
| AC               | .077<br>.087    | <u>.0852</u> inches  |

Tw  
10/22/26



Ball Brothers Research Corporation

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BOULDER COLORADO 80302

DOC NO 49961

DATE 25

REV

CODE IDENT NO 13993

SHEET

### Data Sheet 3

#### 4.1.2 Weight Measurement

##### Instrument Assembly (Head)

Required

<499 gms.

Actual

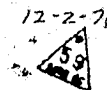
5686 gm.



##### Electronics Assembly

<998 gms.

1109 gm.



SEE  
E.O. 13  
TO 49961.

#### 4.1.3 Center of Gravity Measurement

##### Instrument Assembly (Figure 2)

N 1.820 inches

P 1.728 inches

M 1.644 inches

##### Electronics Assembly (Figure 3)

AD 3.168 inches

AE 4.021 inches

AF 6.17 inches



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BOULDER COLORADO 80302

DOC NO 49901

DATE           

CODE IDENT NO 13993

SHEET

24

REV           

3/11/05

Data Sheet 4

4.4.3 Lower Heater Trip Point

Required

-10°C to -15°C

Actual

-12.5 °C

4.4.6 Upper Heater Trip Point

Required

-5°C to +5°C

Actual

-3.5 °C

**Ball Brothers Research Corporation**

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BOULDER COLORADO 80302

DOC NO 49961

DATE

19

REV

CODE IDENT NO 13993

SHEET

19

REV

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure 49961.

## 3.8 SERIAL NUMBER

- Scanner head serial number 006.
- Main Electronics serial number 006.

## 3.9 TEST OPERATOR

- Signature of test operator Paul A. Crews.
- Date of start of test Dec 2, 1976.
- Date of End of test Dec 2, 1976.

*Dimensions  
Verified 12/2/76*4.1.1 Dimensional Measurements

## Instrument Assembly (Figure 2)

| <u>Dimension</u> | <u>Required</u> | <u>Actual</u>        |
|------------------|-----------------|----------------------|
| A                | 3.470<br>3.450  | <u>3.461</u> inches  |
| B                | 3.010<br>2.990  | <u>3.005</u> inches  |
| C                | 3.093 Basic     | <u>3.0920</u> inches |
| D                | 2.625 Basic     | <u>2.624</u> inches  |
| E                | .187 Basic      | <u>.191</u> inches   |
| F                | .183 Basic      | <u>.183</u> inches   |
| G                | .175<br>.183    | <u>.1797</u> inches  |
| H                | .005<br>.009    | <u>.002</u> inches   |



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DOC NO 49961

DATE     

CODE IDENT NO 13993

SHEET 20

REV A

Data Sheet 1 (con't)

|   |                            |                     |
|---|----------------------------|---------------------|
| J | 3.95 Maximum               | <u>3.915</u> inches |
| K | <u>.135</u><br><u>.115</u> | <u>.127</u> inches  |
| L | .002 Maximum               | <u>.001</u> inches  |



Data Sheet 2.

4.1.1 Dimensional Measurements

Electronics Assembly (Figure 3)

| <u>Dimension</u> | <u>Required</u>         | <u>Actual</u>                       |
|------------------|-------------------------|-------------------------------------|
| A                | 6.195<br>6.175          | <u>6.1881</u> inches                |
| B                | 6.025<br>6.030          | <u>6.0300</u> inches                |
| C                | 5.847 Basic             | <u>5.852</u><br><u>5.850</u> inches |
| D                | 5.295<br>5.285          | <u>5.285</u> inches                 |
| E                | 46°<br>44°              | <u>45°</u> degrees                  |
| F                | .452<br><del>.442</del> | <u>.452</u> inches                  |
| G                | .169 Basic              | <u>.169</u> inches                  |
| H                | .085<br>.075            | <u>.0790</u> inches                 |
| J                | 8.135<br>8.115          | <u>8.1261</u> inches                |
| K                | 7.965<br>7.970          | <u>7.9700</u> inches                |
| L                | 7.787 Basic             | <u>7.790</u> inches                 |
| M                | .185<br>.193            | <u>.1906</u> inches                 |



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DATE

CODE IDENT NO 13993

SHEET 22 REV A

**Data Sheet 2 (cont'd)**

| <u>Dimension</u> | <u>Required</u>                    | <u>Actual</u>        |
|------------------|------------------------------------|----------------------|
| N                | <del>.015</del><br><del>.010</del> | <u>.0064</u> inches  |
| P                | .005                               | <u>OK</u> inches     |
| Q                | .094<br>.099                       | <u>.0967</u> inches  |
| R                | 1.360<br>1.340                     | <u>1.359</u> inches  |
| S                | .087<br>.092                       | <u>.0890</u> inches  |
| T                | .005                               | <u>.002</u> inches   |
| U                | 7.960<br>7.955                     | <u>7.945</u> inches  |
| V                | 46°<br>44°                         | <u>45°</u> degrees   |
| W                | 5.245<br>5.255                     | <u>5.251</u> inches  |
| X                | 6.015<br>6.020                     | <u>6.0160</u> inches |
| Y                | .462<br>.472                       | <u>.468</u> inches   |
| Z                | .075<br>.085                       | <u>.0850</u> inches  |
| AA               | .169 Basic                         | <u>.1688</u> inches  |
| AB               | .085<br>.075                       | <u>.0785</u> inches  |
| AC               | .077<br>.087                       | <u>.0843</u> inches  |

SEE  
WDR #A30539  
A30539

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BOULDER, COLORADO 80302

DOC NO 49961

DATE

25

CODE IDENT NO 13993

SHEET

REV

**Data Sheet 3****4.1.2 Weight Measurement****Instrument Assembly (Head)****Required**

&lt;499 gms.

**Actual**568 gm.

12-6-76

**Electronics Assembly**

&lt;998 gms.

1103 gm.

12-6-76

SEE  
E.O. 'B'  
TO 49961**4.1.3 Center of Gravity Measurement****Instrument Assembly (Figure 2)**N 1.527 inchesP 1.693 inchesM 1.348 inches**Electronics Assembly (Figure 3)**AD 4.010 inchesAE 2.984 inchesAF .596 inches



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BOULDER, COLORADO 80302

DOC NO 49961

DATE       

CODE IDENT NO 13993

SHEET 24 REV       

Data Sheet 4

4.4.3 Lower Heater Trip Point

Required

-10°C to -15°C

Actual

-12 °C

4.4.6 Upper Heater Trip Point

Required

-5°C to +5°C

Actual

-1 °C



APPENDIX F  
OPTICAL AND ELECTRICAL



Data Sheet J

Paragraph numbers correspond with paragraph numbers of Test Procedure, Performance-Panoramic Attitude Sensor, 49959.

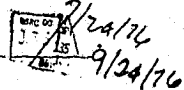
3.2 SERIAL NUMBER

- Scanner head serial number 002
- Main Electronics serial number 002

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3.3 TEST OPERATOR

- Signature of test operator John C. Thul
- Date of start of test 7/24/76 1045
- Date of end of test 7/24/76 2200



3.4 EQUIPMENT REQUIRED

- Visicorder, Honeywell 1508, S/N <sup>BBRC 5362</sup> ~~B-9808~~, Cal. Due N/R
- High Voltage Power Supply, Fluke 301C or equivalent  
S/N B-9908
- Oscilloscope with camera, Tektronix ~~547~~ or equivalent  
7633 S/N C-9082, Cal. date Nov 17, 76
- Current probe, Tektronix P6042 or equivalent —,  
S/N BBRC 8221, Cal. date 1/3/77
- DVM, II-P ~~3440~~ or equivalent HP 3465A, S/N C-9247,  
Cal. date 1/1/77
- Current Meter, Weston 911 or equivalent —,  
S/N NAS-4-414, Cal. date 1/2/77
- VOM, Simpson ~~270~~ or equivalent HP 3465A,  
S/N C-9255, Cal. date 1/1/77
- Precision power supply, II-P 6114A or equivalent —,  
S/N C-8795, Cal. date 1/22/76
- Pulse generator, Tektronix 2102 or equivalent —,  
S/N BBRC-8226, Cal. date 11/5/76
- X-Y Plotter, II-P 7047A or equivalent —,  
S/N C-9047, Cal. date 11/19/76
- Dividing Head, 2 axis, Leitz Imperial Series 72 or  
equivalent —, S/N B-12611, Cal. date 1/12/76



## Data Sheet 2

## 3.6.1 Self Check

Check ☒

## 3.6.2 Test Set Supply Voltages

| FUNCTION | MEASUREMENT | REQUIREMENT |
|----------|-------------|-------------|
| +28v     | 0.69 mA     | 0.7 + 0.07  |
| +12v     | 0.59 mA     | 0.6 + 0.06  |
| +10v     | 0.52 mA     | 0.5 + 0.05  |
| + 8v     | 0.90 mA     | 0.8 + 0.08  |
| + 5v     | 0.49 mA     | 0.5 + 0.05  |
| - 5v     | 0.52 mA     | 0.5 + 0.05  |

## 4.1.1 Ground Continuity

| Measure from<br>Pin to Pin    | Function     | Measurement                                 | Requirement |
|-------------------------------|--------------|---------------------------------------------|-------------|
| 20 Electronics box<br>chassis | CHASSIS GND. | 0.05 <del>0.13</del> Ohm <i>Sam 7/24/74</i> | <0.2 Ohms   |
| 20 21                         | CHASSIS GND. | 0.02 Ohm                                    | <0.2 Ohms   |
| 17 19                         | 28v Ret.     | 0.06 Ohm                                    | <0.2 Ohms   |
| 12 13                         | SIG. GND.    | 0.18 Ohm                                    | <0.2 Ohms   |

## 4.1.2 Ground Isolation

| Measure from<br>Pin to Pin | Function  | Measurement | Requirement     |
|----------------------------|-----------|-------------|-----------------|
| 20 12                      | SIG. GND. | >10M Ohm    | >100 k $\Omega$ |
| 20 17                      | 28v Ret.  | >10M Ohm    | >100 k $\Omega$ |

## 4.2.1 Thermistor Continuity

| Measure from<br>Pin to Pin | Function                     | Measurement       | Requirement        |
|----------------------------|------------------------------|-------------------|--------------------|
| 14 15                      | Elect. Thms. 1 ( $R_{ct1}$ ) | 11.114 k $\Omega$ | 5k to 15k $\Omega$ |
| 33 34                      | Elect. Thms. 2 ( $R_{ct2}$ ) | 11.144 k $\Omega$ | 5k to 15k $\Omega$ |
| 35 36                      | Scan. Thms. 1 ( $R_{st1}$ )  | 11.118 k $\Omega$ | 5k to 15k $\Omega$ |
| 37 5                       | Scan. Thms. 2 ( $R_{st2}$ )  | 11.088 k $\Omega$ | 5k to 15k $\Omega$ |

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### Data Sheet 3

#### 4.2.2 Electronics Thermistor Resistance

$$\Delta R = \frac{(R_{et1} - R_{et2}) \times 100\%}{R_{et1}} = \frac{(11.114 \text{ k}\Omega - 11.144 \text{ k}\Omega) \times 100\%}{11.114 \text{ k}\Omega}$$

$$R_{et1} = -0.3 \%$$

Requirement:  $\pm 4\%$

#### 4.2.3 Scanner Thermistor Resistance

$$\Delta R = \frac{(R_{st1} - R_{st2}) \times 100\%}{R_{st1}} = \frac{(11.118 \text{ k}\Omega - 11.088 \text{ k}\Omega) \times 100\%}{11.118 \text{ k}\Omega}$$

$$R_{st1} = 0.27 \%$$

Requirement:  $\pm 4\%$

#### 4.2.4 Thermistor Isolation

| Measure from<br>Pin to Pin |    | Function       | Measurement                | Requirement             |
|----------------------------|----|----------------|----------------------------|-------------------------|
| 14                         | 20 | Elect. Thms. 1 | $> 10,000 \text{ k}\Omega$ | $> 100 \text{ k}\Omega$ |
| 34                         | 20 | Elect. Thms. 2 | $94.6 \text{ k}\Omega$     | $> 100 \text{ k}\Omega$ |
| 35                         | 20 | Scan. Thms. 1  | $> 10,000 \text{ k}\Omega$ | $> 100 \text{ k}\Omega$ |
| 37                         | 20 | Scan. Thms. 2  | $> 10,000 \text{ k}\Omega$ | $> 100 \text{ k}\Omega$ |

#### 4.3.3 Initial Turn On

Check ☒

#### 4.4.3 Idle Input Current

| Function                          | Measurement       | Requirement                       |
|-----------------------------------|-------------------|-----------------------------------|
| 28v input current<br>( $I_{in}$ ) | $44 \text{ mA}$   | $50 \text{ mA} \pm 25 \text{ mA}$ |
| 28v input voltage<br>( $E_{in}$ ) | $27.88 \text{ V}$ | $28 \text{ V} \pm 0.28 \text{ V}$ |

#### 4.4.4 Idle Input Power

$$P_i = E_{in} \times I_{in}$$

$$= 27.88 \text{ V} \times 44 \text{ mA}$$

$$= 1221 \text{ mW. Reference reading only.}$$



Data Sheet 4

4.4.6 Scanner Rotation

Check ☒

4.4.7 Running Power

Function

Measurement

28v input current  
( $I_{in}$ )

159 mA

Reference only

28v input voltage  
( $E_{in}$ )

27.84 V

Reference only

$$P_r = E_{in} \times I_{in}$$

$$= 27.84V \times 159 \text{ mA}$$

$$= 4427 \text{ mW}$$

Requirement <5.0 watts

4.4.11 Main Electronics Power

Function

Measurement

28v input current  
( $I_{in}$ )

25 mA

Reference only

28v input voltage  
( $E_{in}$ )

27.92 V

Reference only

$$P_e = E_{in} \times I_{in}$$

$$= 27.92V \times 25 \text{ mA}$$

$$P_e = 698 \text{ mW}$$

Requirement <1.0 watts

4.5 Power On Initialize

4.5.3 ☒ Check

4.5.5 ☒ Check

$$4.5.7 \text{ OFFSET} = \frac{AOS1 + LOS1 + AOS2 + LOS2 + AOS3 + LOS3 - 1060}{6}$$

*Handwritten: 14, 16, 123, 124, 382, 387*

$$\text{OFFSET} = \frac{-1 \text{ mV } 7/24/76}{-1.5}$$

Requirement: + 3

4.5.8 ☒ Check

4.5.9 ☒ Check



Data Sheet 5

4.6.1 Analog Telem Calibration

| Measure from<br>Pin to Pin |    | Function     | Measurement    | Requirement |
|----------------------------|----|--------------|----------------|-------------|
| 12                         | 9  | + 5v MONITOR | <u>4.137</u> V | 4.0 + 1.0V  |
| 12                         | 10 | +20v MONITOR | <u>4.016</u> V | 4.0 + 1.0V  |

4.7.2 Scanner Revolution Rate

| Rate (R) | Rate Readout | Measured Time   | Nominal Time |
|----------|--------------|-----------------|--------------|
| 0        | <u>0</u>     | <u>52</u> sec.  | 52 sec.      |
| 1        | <u>1</u>     | <u>26</u> sec.  | 26 sec.      |
| 2        | <u>2</u>     | <u>13</u> sec.  | 13 sec.      |
| 3        | <u>3</u>     | <u>6.5</u> sec. | 6.5 sec.     |

4.8 Invalid Data Test

4.8.1 ✓ Check

4.8.2 ✓ Check

4.9 CW-CCW Test

4.9.2 ✓ Check

4.9.4 ✓ Check

4.9.5 ✓ Check

4.9.6 ✓ Check

4.9.7 ✓ Check

4.10 Sector Test

4.10.2 ✓ Check

4.10.3 ✓ Check

4.10.4 ✓ Check

4.10.5 ✓ Check

4.10.6 ✓ Check

4.10.7 ✓ Check

4.10.8 ✓ Check

4.10.9 ✓ Check

4.10.10 ✓ Check

## Data Sheet 6

|         |                |
|---------|----------------|
| 4.10.11 | <u>✓</u> Check |
| 4.10.12 | <u>✓</u> Check |
| 4.10.13 | <u>✓</u> Check |
| 4.10.14 | <u>✓</u> Check |
| 4.10.15 | <u>✓</u> Check |
| 4.10.16 | <u>✓</u> Check |
| 4.10.17 | <u>✓</u> Check |
| 4.10.18 | <u>✓</u> Check |
| 4.10.19 | <u>✓</u> Check |
| 4.10.20 | <u>✓</u> Check |
| 4.10.21 | <u>✓</u> Check |
| 4.10.22 | <u>✓</u> Check |
| 4.10.23 | <u>✓</u> Check |
| 4.10.24 | <u>✓</u> Check |
| 4.10.25 | <u>✓</u> Check |
| 4.10.26 | <u>✓</u> Check |
| 4.10.27 | <u>✓</u> Check |
| 4.10.28 | <u>✓</u> Check |
| 4.10.29 | <u>✓</u> Check |
| 4.10.30 | <u>✓</u> Check |
| 4.10.31 | <u>✓</u> Check |
| 4.10.32 | <u>✓</u> Check |
| 4.10.33 | <u>✓</u> Check |
| 4.10.34 | <u>✓</u> Check |
| 4.10.35 | <u>✓</u> Check |
| 4.10.36 | <u>✓</u> Check |
| 4.10.37 | <u>✓</u> Check |



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SHEET 60

REV

### Data Sheet 7

4.11.6 Sector Check

Check ☒

4.11.7 Power Supply Variation

| <u>POWER<br/>SUPPLY</u> | <u>AOS/LOS<br/>DISPLAY</u>          | <u>O<br/>READOUT</u>                |
|-------------------------|-------------------------------------|-------------------------------------|
| 26.60 $\pm$ 0.26v (-4%) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 28.84 $\pm$ 0.28v (+2%) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 28.00 $\pm$ 0.28v (NOM) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

4.11.9 Clock Frequency Variations

| <u>Frequency at Failure</u> | <u>Requirement</u> |
|-----------------------------|--------------------|
| Upper <u>20</u> MHz         | >12.9 MHz          |
| Lower <u>5</u> MHz          | <10.0 MHz          |

4.12 Slow Data Rate

4.12.5 ☒ Check

4.12.6 ☒ Check

4.12.7 ☒ Check

4.12.8 ☒ Check

4.12.9 ☒ Check

4.12.10 ☒ Check

4.12.11 ☒ Check

4.12.12 ☒ Check

4.13 Spherical Mode Check

4.13.4 ☒ Check

4.13.5 ☒ Check

4.13.6 ☒ Check

4.13.7 ☒ Check

4.13.8 ☒ Check

4.13.9 ☒ Check

4.13.10 ☒ Check



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Data Sheet 8

|         |                                           |
|---------|-------------------------------------------|
| 4.13.11 | <input checked="" type="checkbox"/> Check |
| 4.13.12 | <input checked="" type="checkbox"/> Check |
| 4.13.13 | <input checked="" type="checkbox"/> Check |
| 4.13.14 | <input checked="" type="checkbox"/> Check |
| 4.13.15 | <input checked="" type="checkbox"/> Check |
| 4.13.16 | <input checked="" type="checkbox"/> Check |
| 4.13.17 | <input checked="" type="checkbox"/> Check |
| 4.13.18 | <input checked="" type="checkbox"/> Check |
| 4.13.19 | <input checked="" type="checkbox"/> Check |
| 4.13.20 | <input checked="" type="checkbox"/> Check |
| 4.13.21 | <input checked="" type="checkbox"/> Check |
| 4.13.22 | <input checked="" type="checkbox"/> Check |
| 4.13.23 | <input checked="" type="checkbox"/> Check |
| 4.13.24 | <input checked="" type="checkbox"/> Check |
| 4.13.25 | <input checked="" type="checkbox"/> Check |
| 4.13.26 | <input checked="" type="checkbox"/> Check |
| 4.13.27 | <input checked="" type="checkbox"/> Check |
| 4.13.28 | <input checked="" type="checkbox"/> Check |
| 4.13.29 | <input checked="" type="checkbox"/> Check |
| 4.13.30 | <input checked="" type="checkbox"/> Check |
| 4.13.31 | <input checked="" type="checkbox"/> Check |
| 4.13.32 | <input checked="" type="checkbox"/> Check |
| 4.13.33 | <input checked="" type="checkbox"/> Check |
| 4.13.34 | <input checked="" type="checkbox"/> Check |
| 4.13.35 | <input checked="" type="checkbox"/> Check |
| 4.13.36 | <input checked="" type="checkbox"/> Check |





Data Sheet 9

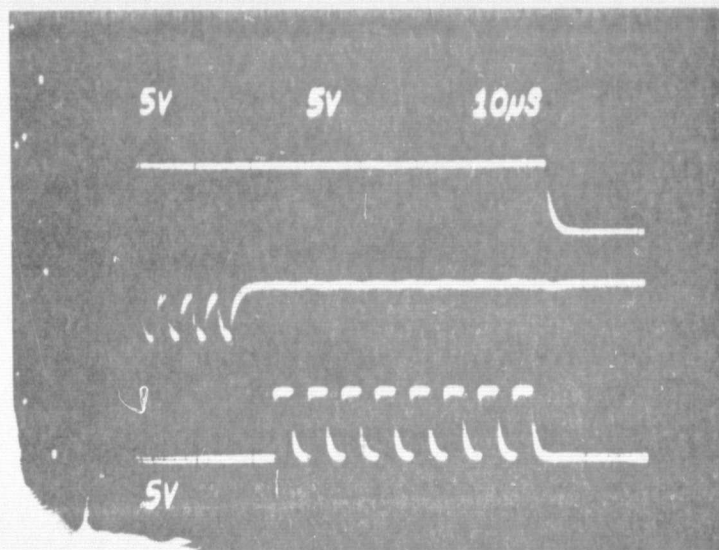
4.14.2

2v/cm

2v/cm

2v/cm

10 $\mu$ s/cm



DWG

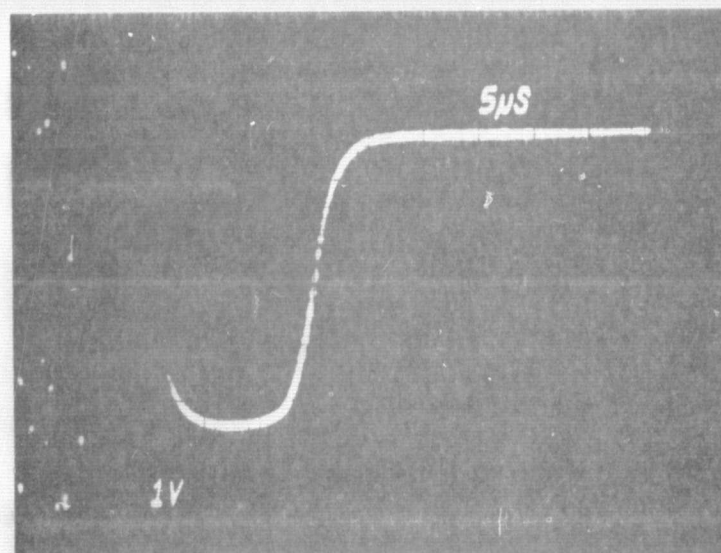
Burst  
Clock

Shift  
Pulses

4.14.6

1v/cm

5 $\mu$ s/cm



Load  
Pulse

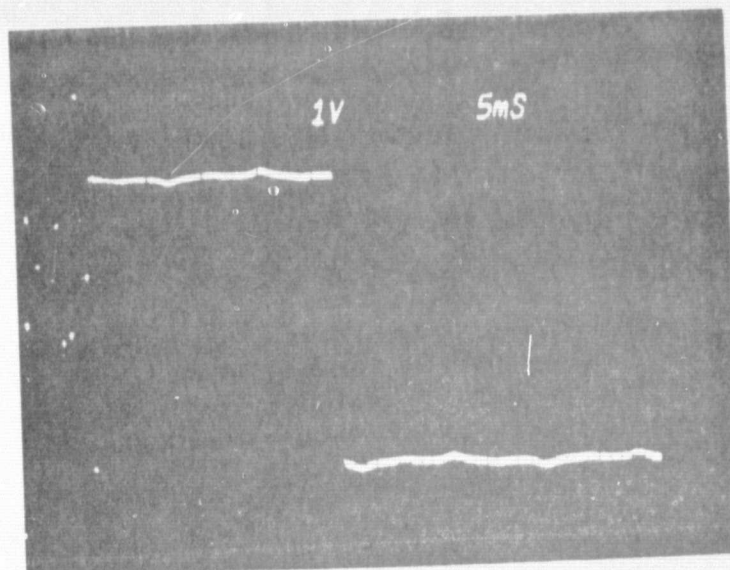
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Data Sheet 10

4.14.11

1v/cm

5ms/cm

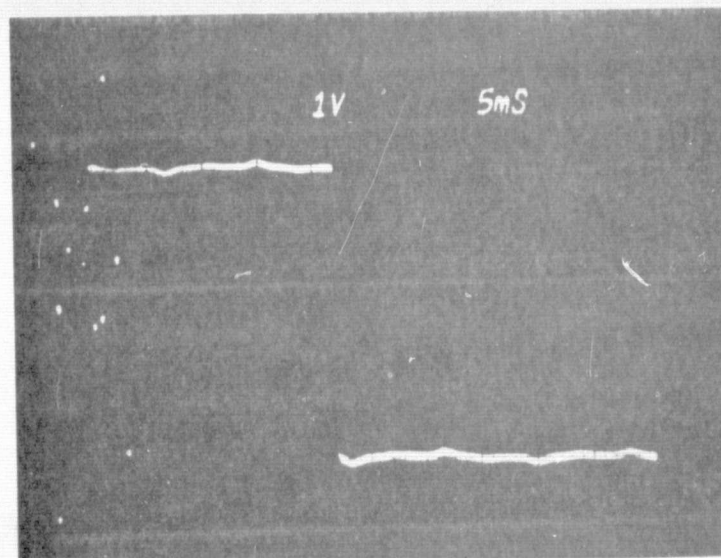


Sun  
Slit  
#1

4.14.14

1v/cm

5ms/cm



Sun  
Slit  
#2

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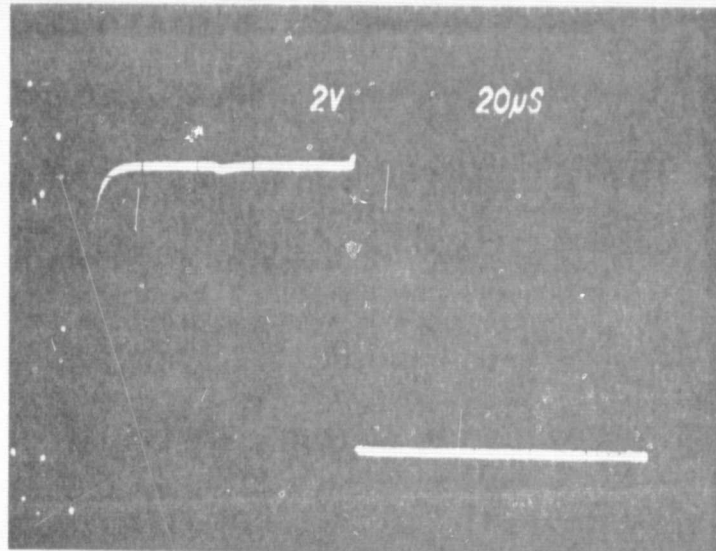
SHEET 64 REV

Data Sheet 11

4.14.17

2v/cm

20ms/cm



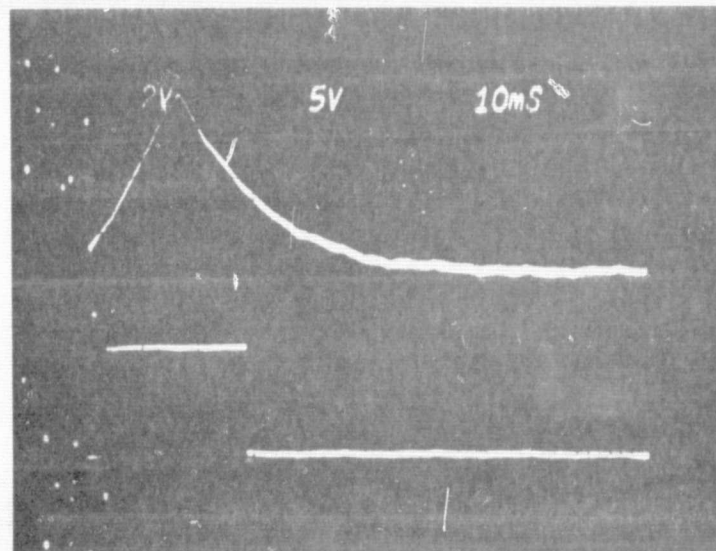
10v  
Sun  
Pulse

4.14.21

2v/cm

5v/cm

10ms/cm



Sun  
Slit  
Analog

Sun  
Slit

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Data Sheet 12

4.14.22 Sun Slit Amplitude

$V_{pk} = 7.0$  volts Reference only

$\frac{V_{pk}}{2} = \frac{7.0}{2} = 3.5$  volts Reference only

4.14.23 Sun Slit Failure Edge

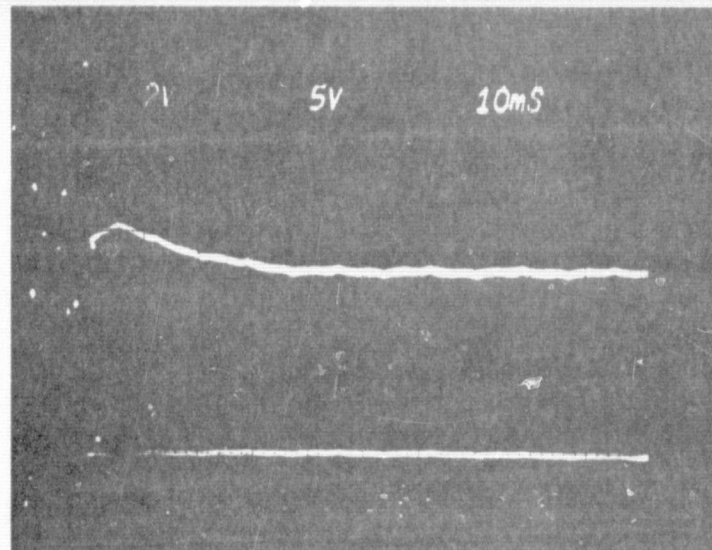
$3.5$  Volts, Requirement:  $\frac{V_{pk}}{2} \pm 0.5V$

4.14.24 Minimum Threshold Photo

2v/cm

5v/cm

5ms/cm



Sun Slit  
Analog

Sun  
Slit

4.14.25 Minimum Threshold Measurement

$2.2$  Volts, Requirement  $2.25 \pm 0.5V$

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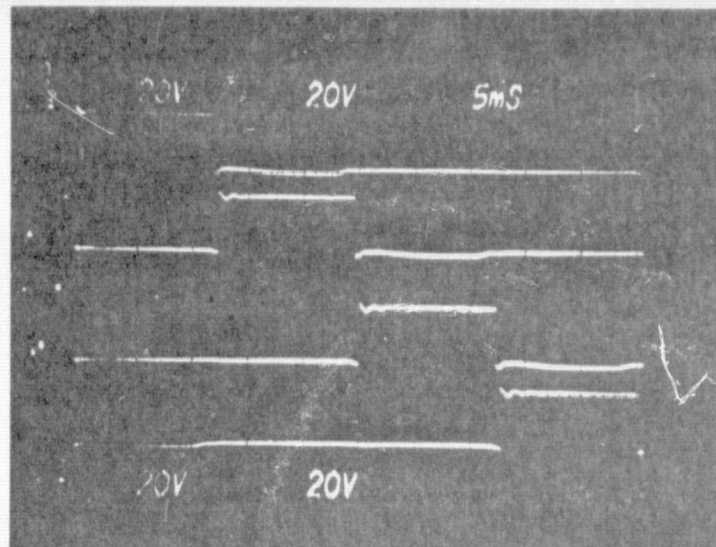


## Data Sheet 13

## 4.14.28 Motor Drive Pulses

20v/cm

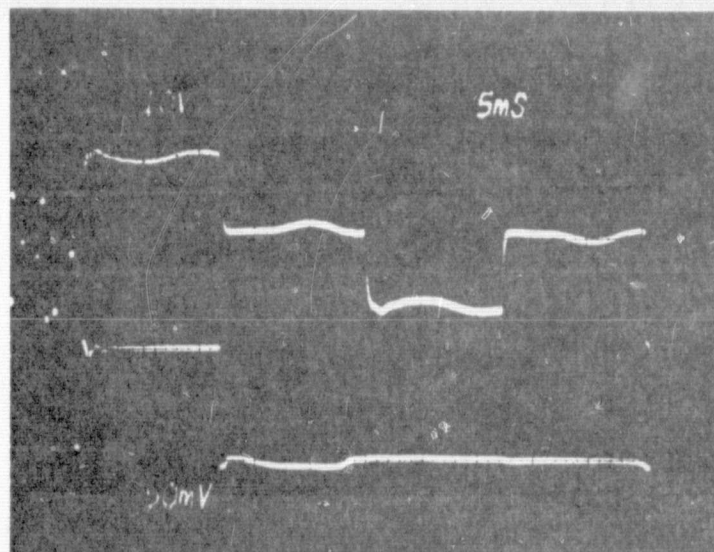
5ms/cm

 $\Phi A$  $\Phi B$  $\Phi C$  $\Phi D$ 4.14.33  $\Phi A$  Current Photograph

100mA/cm

10v/cm

26ms/cm

 $\Phi A$  motor  
current $\Phi A$  motor  
voltage



Data Sheet 14

4.14.35  $\Phi A$  Current Measurement

Measurement

280 mA

Requirement

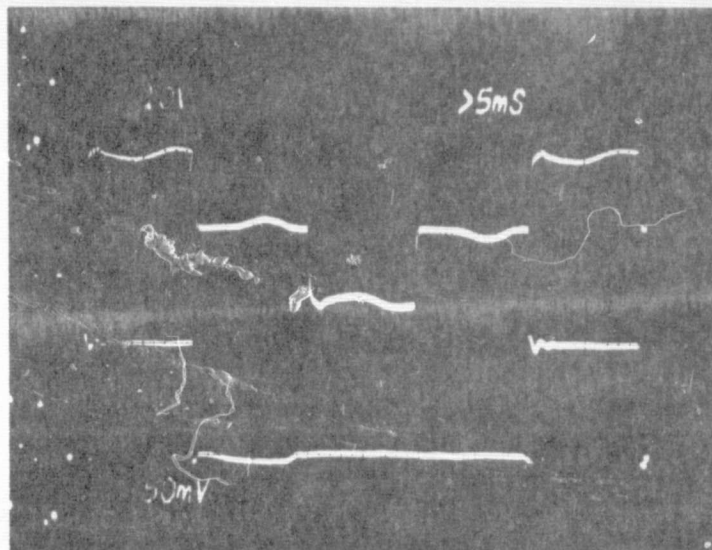
300 mA max excluding spikes

4.14.37  $\Phi B$  Current Photograph

100mA/cm

10V/cm

6ms/cm



$\Phi A$  motor  
voltage

$\Phi B$  motor  
current

4.14.38  $\Phi B$  Current Measurement

Measurement

280 mA

Requirement

300 mA max excluding spikes

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Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt Angle (degrees) | Peak Amplitude (volts) | (1)<br>-Az Angle at 1/2 PK Amp (degrees) | (2)<br>+Az Angle at 1/2 PK Amp (degrees) |
|----------------------|------------------------|------------------------------------------|------------------------------------------|
| +1.00                | —                      | —                                        | —                                        |
| 0.75                 | —                      | —                                        | —                                        |
| 0.50                 | 1.25                   | -90°                                     | +90°                                     |
| 0.25                 | 4.35                   | -90°                                     | +90°                                     |
| 0.0                  | 6.05                   | -90°                                     | +90°                                     |
| -0.25                | 3.50                   | -90°                                     | +90°                                     |
| -0.50                | 1.25                   | -90°                                     | +89°                                     |
| -0.75                | —                      | —                                        | —                                        |
| -1.00                | —                      | —                                        | —                                        |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

✓ Check



Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table

| Azimuth<br>Angle<br>(degrees) | Space Corrected<br>Peak<br>Amplitude<br>(volts) | (1)<br>-Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | F.O.V. |
|-------------------------------|-------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------|
| -90-85°                       | 9.55                                            | $\epsilon^- = -0.38^\circ$                       | $\epsilon^+ = 0.27^\circ$                        | 0.65°  |
| -45                           | 10.41                                           | $\epsilon^- = -0.38^\circ$                       | $\epsilon^+ = 0.28^\circ$                        | 0.67°  |
| 0                             | 9.79                                            | $\epsilon^- = -0.37^\circ$                       | $\epsilon^+ = 0.30^\circ$                        | 0.67°  |
| +45                           | 8.38                                            | $\epsilon^- = -0.38^\circ$                       | $\epsilon^+ = 0.27^\circ$                        | 0.65°  |
| 90+85°                        | 8.45                                            | $\eta^- = -0.35^\circ$                           | $\eta^+ = 0.32^\circ$                            | 0.67°  |

The sun sensor field of view (column 1 - column 2) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude



Check

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\epsilon^- + \epsilon^+)}{2}$$

$$= -0.035^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(\epsilon_+ + \epsilon_- + \eta_- + \eta_+)}{4}$$

$$= 0.02^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge trip point offset  $0.30^\circ$

Reference Only



# Data Sheet 17

4.16.7

- Transcribe the 2-axis table settings and complete the following table and calculate the Azimuth Field of View (FOV = | column 4 - column 3 |).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Azimuth Angle<br>1/2 Pk. Amp. | Positive<br>Azimuth Angle<br>1/2 Pk. Amp. | Azimuth<br>FOV*                             | Require-<br>ment |
|--------------------------------|--------------------|-------------------------------------------|-------------------------------------------|---------------------------------------------|------------------|
| 000                            | 0° (x-axis)        | $\alpha_1 = \underline{0.111^\circ}$      | $\alpha_2 = \underline{0.791}$            | $ \alpha_2 - \alpha_1  = \underline{0.680}$ | 0.71 ± 0.05°     |
| 128                            | 90°                | $\beta_1 = \underline{0.154^\circ}$       | $\beta_2 = \underline{0.862}$             | $ \beta_2 - \beta_1  = \underline{0.708}$   | 0.71 ± 0.05°     |
| 256                            | 180°               | $\gamma_1 = \underline{0.069}$            | $\gamma_2 = \underline{0.753}$            | $ \gamma_2 - \gamma_1  = \underline{0.683}$ | 0.71 ± 0.05°     |
| 384                            | 270° (y-axis)      | $\delta_1 = \underline{0.060}$            | $\delta_2 = \underline{0.763}$            | $ \delta_2 - \delta_1  = \underline{0.702}$ | 0.71 ± 0.05°     |

\* The scanner Field of View shall be 0.71° ± 0.05° at 50% of the peak amplitude.

- Calculate the Zero Scan Angle Error using the following equation:

$$\text{Error} = \frac{|\alpha_2 + \alpha_1|}{2}$$

$$\text{Error} = \underline{0.451}^\circ$$

$$\frac{\text{Requirement}}{0^\circ \pm 0.7^\circ}$$

- Calculate the scanner position accuracy according to the equations below:

| Encoder<br>Position | Reference<br>Angle | Error                                                                      | Requirement |
|---------------------|--------------------|----------------------------------------------------------------------------|-------------|
| 128                 | 90°                | $(\alpha_1 + \alpha_2 - \beta_1 - \beta_2)/2 = \underline{-0.057}^\circ$   | ± 0.1°      |
| 256                 | 180°               | $(\alpha_1 + \alpha_2 - \gamma_1 - \gamma_2)/2 = \underline{+0.039}^\circ$ | ± 0.1°      |
| 384                 | 270°               | $(\alpha_1 + \alpha_2 - \delta_1 - \delta_2)/2 = \underline{+0.039}^\circ$ | ± 0.1°      |



## Data Sheet 18

4.16.9

- Transcribe the Z-axis table readings to the following table and calculate the Elevation Field of View (FOV= |column 4 - column 3|).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Elevation<br>Angle<br>1/2 Pk. amp | Positive<br>Elevation<br>Angle<br>1/2 Pk. amp | Elevation<br>FOV*               | Require<br>ment       |
|--------------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------|-----------------------|
| 000                            | 0° (x-axis)        | $\alpha_- = -0.167$                           | $\alpha_+ = 0.550$                            | $ \alpha_+ - \alpha_-  = 0.717$ | $0.71 \pm 0.05^\circ$ |
| 128                            | 90°                | $\beta_- = -0.133$                            | $\beta_+ = 0.533$                             | $ \beta_+ - \beta_-  = 0.667$   | $0.71 \pm 0.05^\circ$ |
| 256                            | 180°               | $\gamma_- = -0.133$                           | $\gamma_+ = 0.550$                            | $ \gamma_+ - \gamma_-  = 0.683$ | $0.71 \pm 0.05^\circ$ |
| 384                            | 270° (y-axis)      | $\delta_- = -0.150$                           | $\delta_+ = 0.533$                            | $ \delta_+ - \delta_-  = 0.683$ | $0.71 \pm 0.05^\circ$ |

\*The scanner field of view shall be  $0.71^\circ \pm 0.05^\circ$  at 50% of the peak amplitude.

- Calculate the tilt angle ( $\phi$  in Figure 13) of the plane of the scanner optical axis with respect to the plane of the mounting surface using the following equation.

$$\phi = \tan^{-1} \left( \frac{|\sqrt{\alpha^2 + \beta^2 + \gamma^2 + \delta^2 - 2\alpha\gamma - 2\beta\delta}|}{2} \right)$$

$$\text{where; } \alpha = \tan(\alpha_+ + \alpha_-)/2$$

$$\beta = \tan(\beta_+ + \beta_-)/2$$

$$\gamma = \tan(\gamma_+ + \gamma_-)/2$$

$$\delta = \tan(\delta_+ + \delta_-)/2$$

$$\phi = 0.009^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

- Calculate the direction of maximum tilt response with respect to the zero reference angle ( $\theta$  in Figure 13) using the following equation:

$$\theta = \tan^{-1} \frac{(\delta - \beta)}{(\gamma - \alpha)} = \frac{(\delta - \beta)}{(\gamma - \alpha)} \cdot 90^\circ - \frac{(\delta - \beta)}{|\delta - \beta|} \cdot 90^\circ + 180^\circ \quad \text{Reference only}$$

$$\theta = 333^\circ$$



Date Sheet 19

- Calculate the cone angle (average deviation from a plane) using the following equation:

$$\phi = \frac{(\alpha_- + \alpha_+ + \beta_- + \beta_+ + \gamma_- + \gamma_+ + \delta_- + \delta_+)}{8}$$

$$\phi = 0.198^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

- Calculate the maximum error using the following equation:

$$\text{error} = |\phi| + |\phi| = 0.207^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

## 4.17.7 Backlash Test

Measured

$$0.15^\circ$$

Requirement

$$0.2^\circ \text{ Min } 1/24 \text{ in}$$

## 4.16.13 Scanner Trip-On Point

Measured  $V_{\text{trip-on}}$ 

$$9.098 \text{ V.}$$

Measured  $V_{\text{dark}}$ 

$$8.997 \text{ V.}$$

$$\% \text{ full space moon} = \frac{V_{\text{trip-on}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 10.3\%$$

Requirement  
5% to 20%

## 4.16.15 Scanner Trip-Off Point

Measured Trip-Off

$$9.089 \text{ V.}$$

Measured  $V_{\text{dark}}$ 

$$8.997 \text{ V.}$$

$$\% \text{ full space moon} = \frac{V_{\text{trip-off}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 9.3\%$$

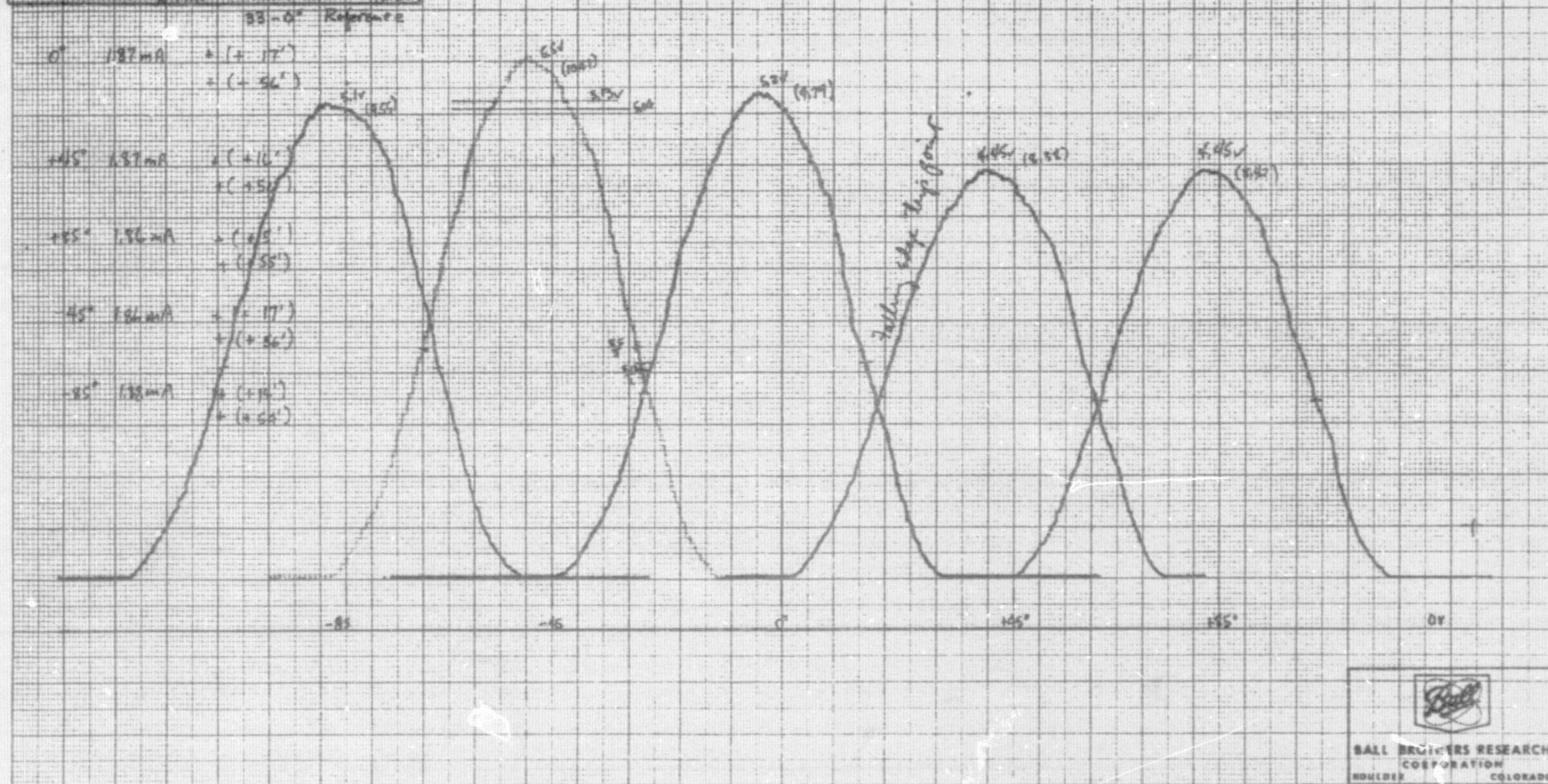
Requirement  
5% to 20%

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2-14

# SENSOR DATA BLOCK

|                                            |                                            |
|--------------------------------------------|--------------------------------------------|
| BLOCK S/N: 002                             | DATE: 7/24/70                              |
| SENSOR: PAS                                | R4.5.8                                     |
| DESC: FINAL PERFORMANCE                    |                                            |
| TEMP:                                      |                                            |
| SENSOR PEAK:                               |                                            |
| SOLAR PEAK:                                |                                            |
| SPACE PEAK:                                |                                            |
| SPACE GAIN:                                |                                            |
| NULL:                                      |                                            |
| X FULL SCALE: $\frac{15}{2.5} \times 10^3$ | Y FULL SCALE: $\frac{10}{2.5} \times 10^3$ |



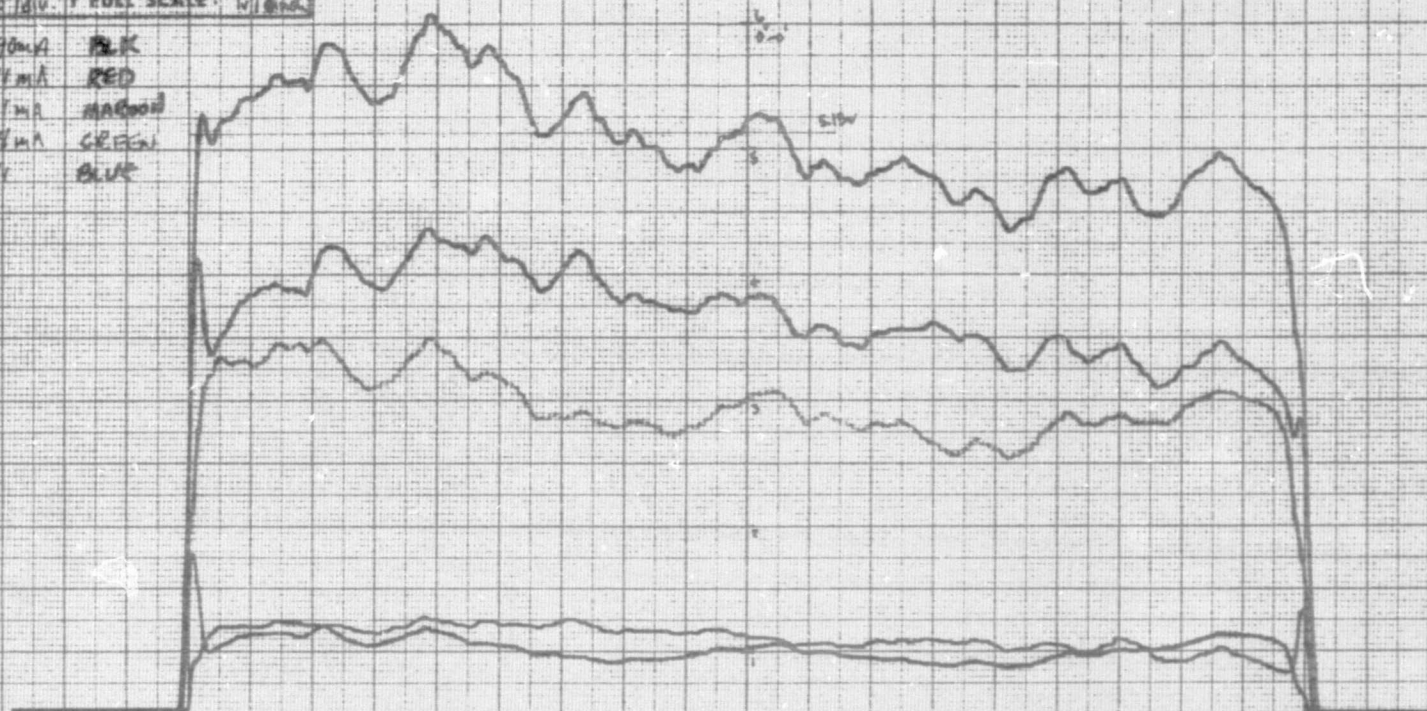


# SENSOR DATA BLOCK

2-15

|                                            |               |
|--------------------------------------------|---------------|
| BLOCK S/N: 002                             | DATE: 7/24/76 |
| SENSOR: PAS                                | P4.15.87      |
| DESC: FINAL PERFORMANCE                    |               |
| TEMP:                                      |               |
| SENSOR PEAK:                               |               |
| SOLAR PEAK:                                |               |
| SPACE PEAK:                                |               |
| SPACE GAIN: NULL                           |               |
| X FULL SCALE: 10/div. Y FULL SCALE: 10/div |               |

0 - 1.90mA BLACK  
 15' - 1.91mA RED  
 30' - 1.91mA MAROON  
 45' - 1.91mA GREEN  
 60' - 1.91mA BLUE



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# SENSOR DATA BLOCK

2-16

|                                           |               |
|-------------------------------------------|---------------|
| BLOCK S/N: 002                            | DATE: 7/24/76 |
| SENSOR: PAS                               | P4.6.9        |
| DESC: FINAL PERFORMANCE                   |               |
| ELEVATION:                                | TEMP:         |
| SENSOR PEAK:                              |               |
| SOLAR PEAK:                               |               |
| SPACE PEAK:                               |               |
| SPACE GAIN:                               | NULL          |
| X FULL SCALE: 10/div Y FULL SCALE: 10/div |               |

REFERENCE 2" - 2"

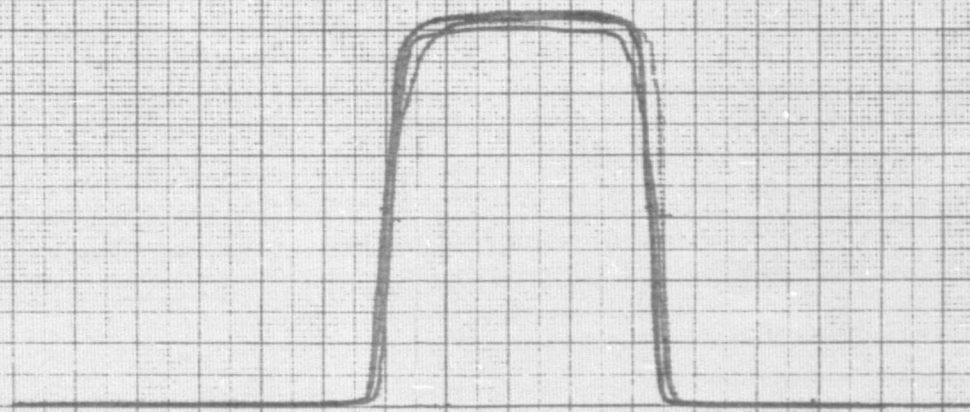
0° + 2" - 75' BLACK  
- 1" - 52'

90° + 2" - 84' RED  
- 1" - 54'

180° + 2" - 75' GREEN  
- 1" - 56'

270° + 2" - 34' BLUE  
- 1" - 53'

0-0 401



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# SENSOR DATA BLOCK

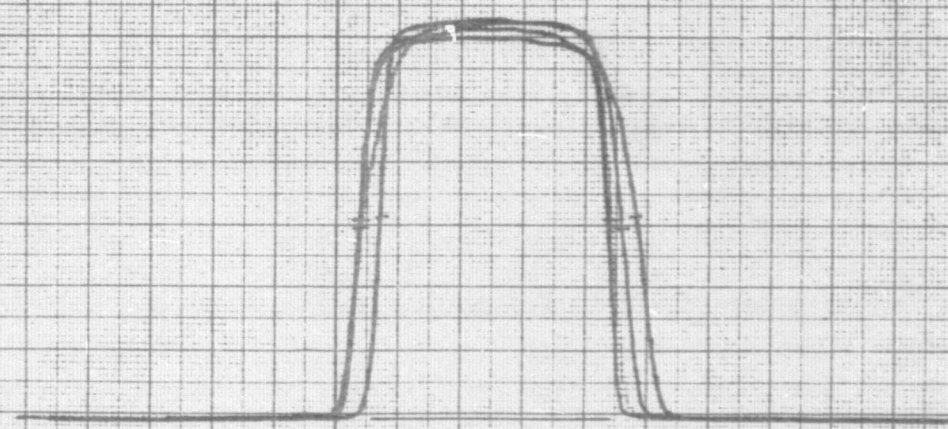
2-17

|                                                       |               |
|-------------------------------------------------------|---------------|
| BLOCK S/N: 002                                        | DATE: 7/29/76 |
| SENSOR: PAS                                           | P46.7         |
| DESC: <del>INITIAL</del> <sup>HEAVY</sup> PERFORMANCE |               |
| AZIMUTH                                               | TEMP:         |
| SENSOR PEAK:                                          |               |
| SOLAR PEAK:                                           |               |
| SPACE PEAK:                                           |               |
| SPACE $\Delta$ H:                                     | NULL:         |
| X FULL SCALE: 10 / 10 Y FULL SCALE: 10 / inch         |               |

TRIP ON 9.089  
TRIP OFF 9.085  
DARK 9.997

|           |                   |
|-----------|-------------------|
| REFERENCE | 0.10" = 10'       |
|           | 0.20" = 20'       |
|           | 0.30" = 30'       |
|           | 0.40" = 40'       |
| 0°        | -12° - 15' - 19"  |
|           | -12° - 53' - 26"  |
| 90°       | -210° - 10' - 10" |
|           | -217° - 01' - 48" |
| 180°      | -200° - 14' - 10" |
|           | -200° - 55' - 10" |
| 270°      | -30° - 13' - 37"  |
|           | -30° - 55' - 46"  |

0°-0' Ref.



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BOULDER, COLORADO 80302

DOC NO 49959

DATE

CODE IDENT NO 13993

SHEET 68 REV A

49002  
FINAL RETEST  
10/7/76

### Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt<br>Angle<br>(degrees) | Peak<br>Amplitude<br>(volts) | (1)<br>-Az Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Az Angle<br>at 1/2 PK Amp<br>(degrees) |
|----------------------------|------------------------------|------------------------------------------------|------------------------------------------------|
|                            |                              |                                                |                                                |
| +1.00                      | —                            | —                                              | —                                              |
| 0.75                       | —                            | —                                              | —                                              |
| 0.50                       | 1.20                         | -90°                                           | 91°                                            |
| 0.25                       | 2.92                         | -90°                                           | 91°                                            |
| 0.0                        | 4.35                         | -90°                                           | 91°                                            |
| -0.25                      | 3.27                         | -88°                                           | 91°                                            |
| -0.50                      | 0.80                         | —                                              | —                                              |
| -0.75                      | —                            | —                                              | —                                              |
| -1.00                      | —                            | —                                              | —                                              |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

✓ Check



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CODE IDENT NO 13993

DOC NO 49959  
DATE  
SHEET 69 REV A

SP002  
FINAL RETEST  
10/7/76

## Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table.

| Azimuth<br>Angle<br>(degrees) | Space Corrected<br>Peak<br>Amplitude<br>(volts) | (1)<br>-Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | F.O.V.<br>(degrees) |
|-------------------------------|-------------------------------------------------|--------------------------------------------------|--------------------------------------------------|---------------------|
| -85                           | 5.37                                            | $\epsilon^- = -0.317$                            | $\epsilon^+ = 0.333$                             | 0.650               |
| -45                           | 6.73                                            | $-0.250$                                         | 0.383                                            | 0.633               |
| 0                             | 7.49                                            | $\xi^- = -0.233$                                 | $\xi^+ = 0.383$                                  | 0.617               |
| +45                           | 7.37                                            | $-0.267$                                         | 0.350                                            | 0.617               |
| 85                            | 5.54                                            | $\eta^- = -0.383$                                | $\eta^+ = 0.300$                                 | 0.683               |

The sun sensor field of view (column 1 - column 2) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

Check  
SEE MDR #A30194

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\xi^- + \xi^+)}{2}$$

$$= \frac{0.075 \text{ sum}}{-0.108}^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(-\epsilon_+ - \epsilon_- + \eta_- + \eta_+)}{4}$$

$$= -0.025^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge Trip Point Offset

$$0.383^\circ$$

Reference Only



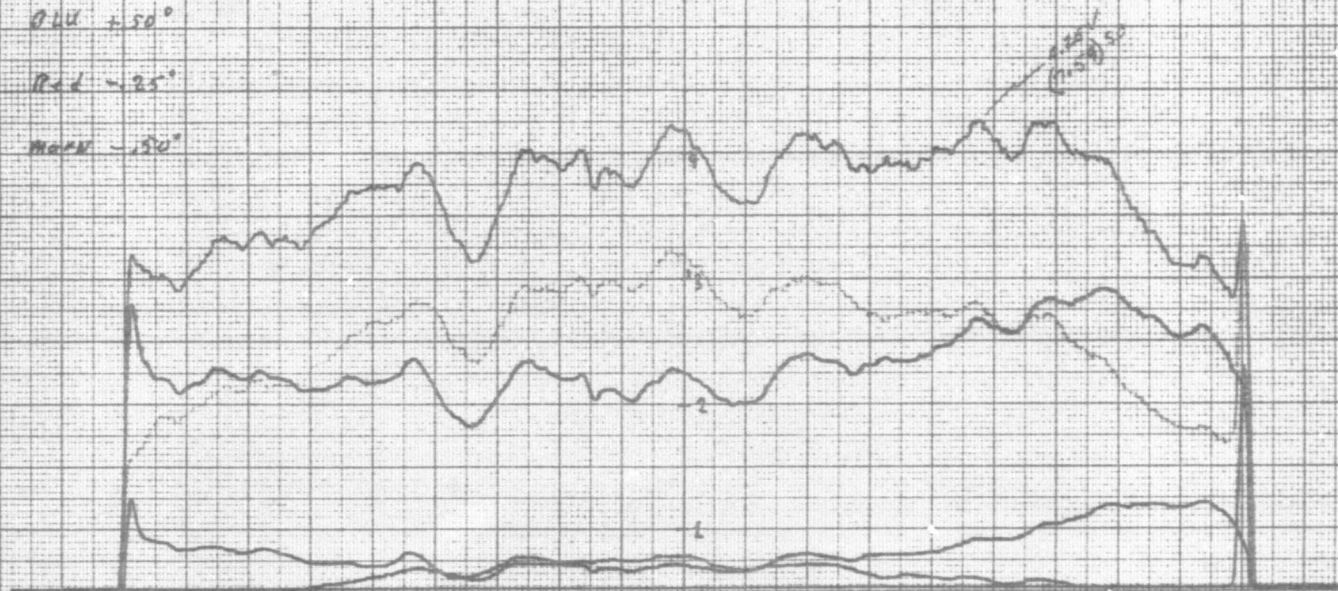
C-3

## SENSOR DATA BLOCK

Z-1

|                      |                      |
|----------------------|----------------------|
| BLOCK S/N: 002       | DATE: 10-7-76        |
| SENSOR: DAS          |                      |
| DESC: FINAL          |                      |
| PERIOD: A20198       | TEMP:                |
| SENSOR PEAK:         |                      |
| SOLAR PEAK:          |                      |
| SPACE PEAK:          |                      |
| SPACE GAIN:          | MULL:                |
| X FULL SCALE: 10°/in | Y FULL SCALE: 10°/in |

STA 1.97 RIN 0°  
 1.97 GRN +25°  
 1.96 OLV +50°  
 1.96 RED -25°  
 1.96 MAGN -150°



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# SENSOR DATA BLOCK

2-2

|                     |                     |
|---------------------|---------------------|
| BLOCK S/N: 002      | DATE: 10-7-76       |
| SENSOR: PHS         |                     |
| DESC: Final         |                     |
| PERIOD: 0.30194     | TEMP:               |
| SENSOR PEAK:        |                     |
| SOLAR PEAK:         |                     |
| SPACE PEAK:         |                     |
| SPACE GAIN:         | NULL:               |
| X FULL SCALE: 10/11 | Y FULL SCALE: 10/11 |

STD 1.94 ALN 0°

Ref -2' 00"  
+ -25' 00"  
+12' 00"

STD 1.94 Red +45°

Ref -2' 00"  
+ -23' 00"  
+14' 00"

STD 1.93 Maroon +85°

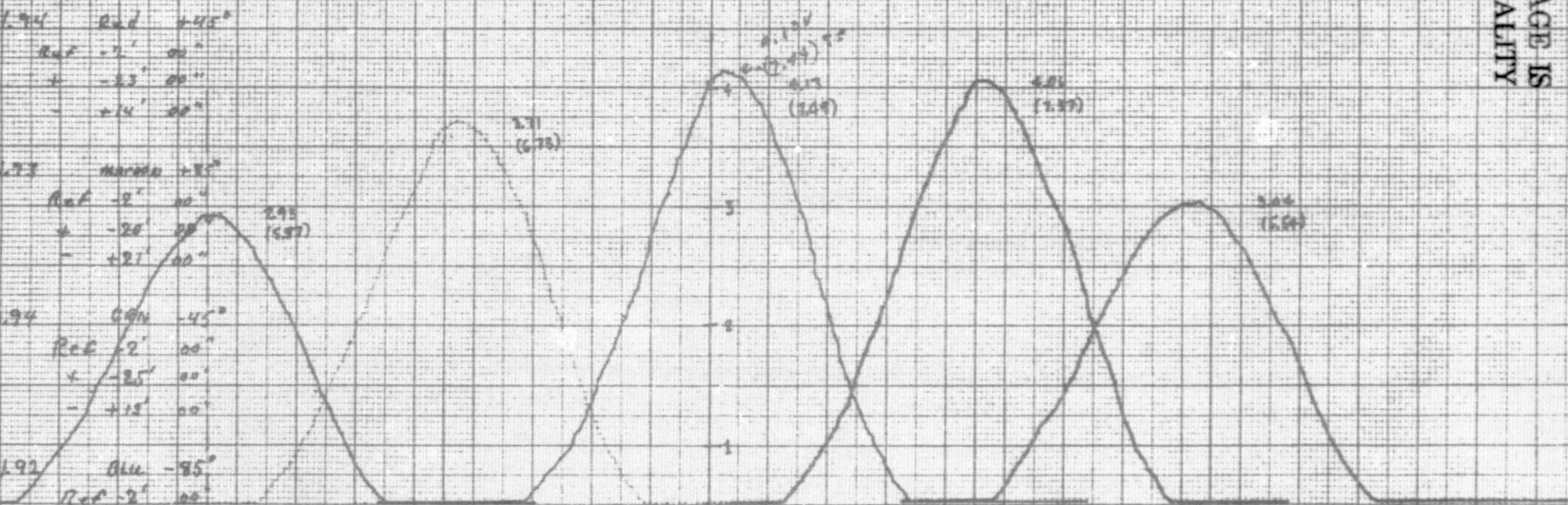
Ref -2' 00"  
+ -20' 00"  
+21' 00"

STD 1.94 GRN -45°

Ref -2' 00"  
+ -25' 00"  
+15' 00"

STD 1.92 BLU -85°

Ref -2' 00"  
+ -22' 00"  
+17' 00"



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# SENSOR DATA BLOCK

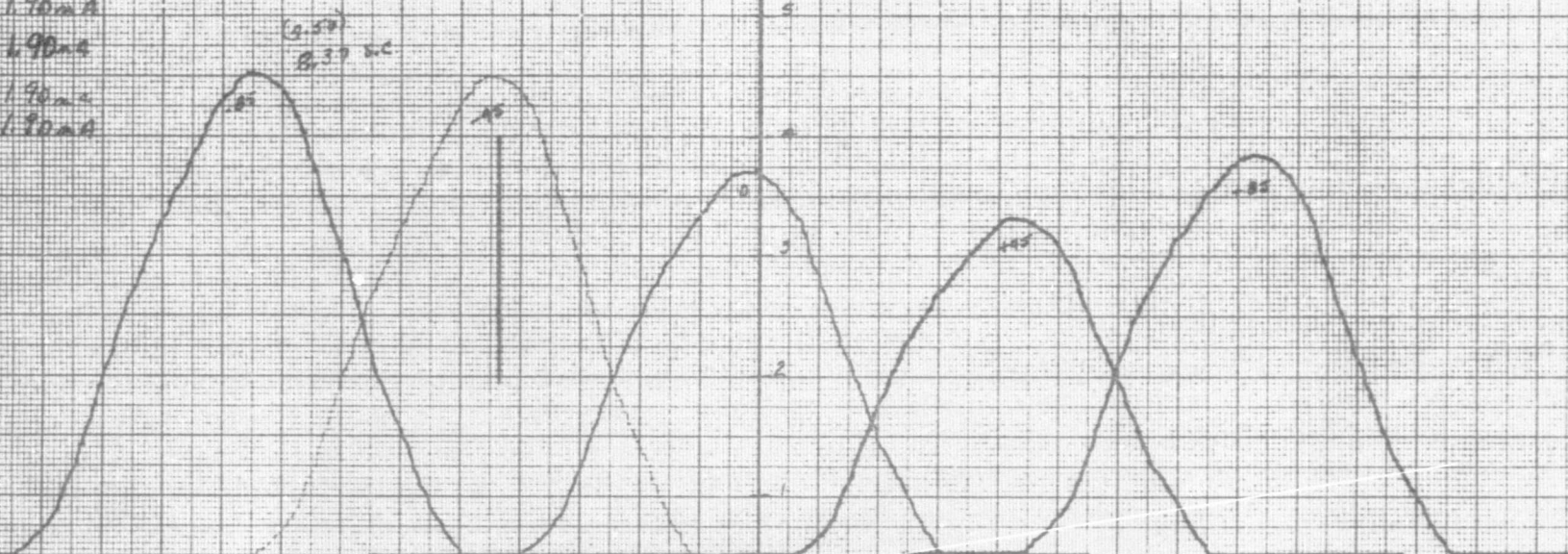
2-3

Q2a

|                               |                     |
|-------------------------------|---------------------|
| BLOCK S/N: 002                | DATE: 9/29/70       |
| SENSOR: PPS                   |                     |
| DESC: Ratent Rev MDR4 A-30198 |                     |
| TEMP                          |                     |
| SENSOR PEAK:                  |                     |
| SOLAR PEAK:                   |                     |
| SPACE PEAK:                   |                     |
| SPACE GAIN:                   | NULL:               |
| X FULL SCALE: 10/mv           | Y FULL SCALE: 10/mv |

HP3 STAY 4

0.7 E 1.91mA  
 -45° 1.90mA  
 -85° 1.90mA  
 +45° 1.90mA  
 +85° 1.90mA



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BR-147 2-65



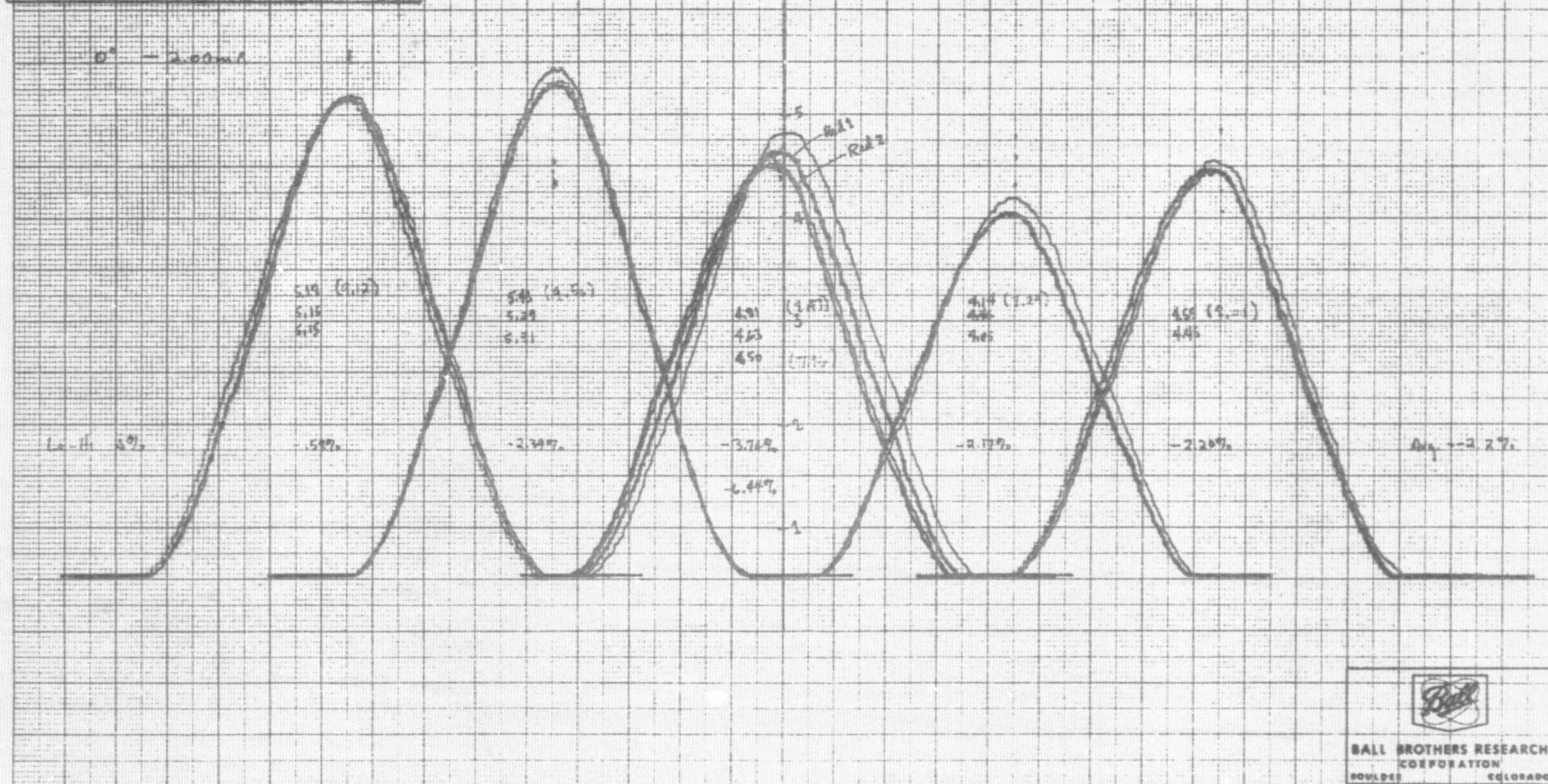


# SENSOR DATA BLOCK

2-5

|                                          |              |
|------------------------------------------|--------------|
| BLOCK S/N: 002                           | DATE: 9/2/76 |
| SENSOR: PAS                              |              |
| DESC: RETEST PER MDR A 30199             |              |
| SW: SUT NUT TORQUE SENSCT TEMP           |              |
| SENSOR PEAK:                             |              |
| SOLE PEAK:                               |              |
| SPACE PEAK:                              |              |
| SPACE GAIN: NULL                         |              |
| X FULL SCALE: 5mV/in Y FULL SCALE: 1W/10 |              |

BLACK 2.00mA 6in-8 1/2  
 1 RED (damp to 2in-1/2) 2.01mA 3in-8 1/2  
 1.99mA  
 GREEN 1.99mA 30in-16  
 BLUE (damp to 2in-1/2) 2.00mA 6in-16  
 1.99mA  
 2 RED (damp to 2in-1/2) 1.99mA 6in-16



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# SENSOR DATA BLOCK

2-6

|                                         |              |
|-----------------------------------------|--------------|
| BLOCK S/N: 002                          | DATE: 9/1/74 |
| SENSOR: PAS                             |              |
| DESC: RETEST PER MDR A32198             |              |
| INITIAL: START OF TORRE SEC. BEARING    |              |
| SENSOR PEAK:                            |              |
| SOLAR PEAK:                             |              |
| SPACE PEAK:                             |              |
| SPACE GAIN: NULL                        |              |
| X FULL SCALE: 5.00 V FULL SCALE: 1.00 V |              |

0° = +14' 00"

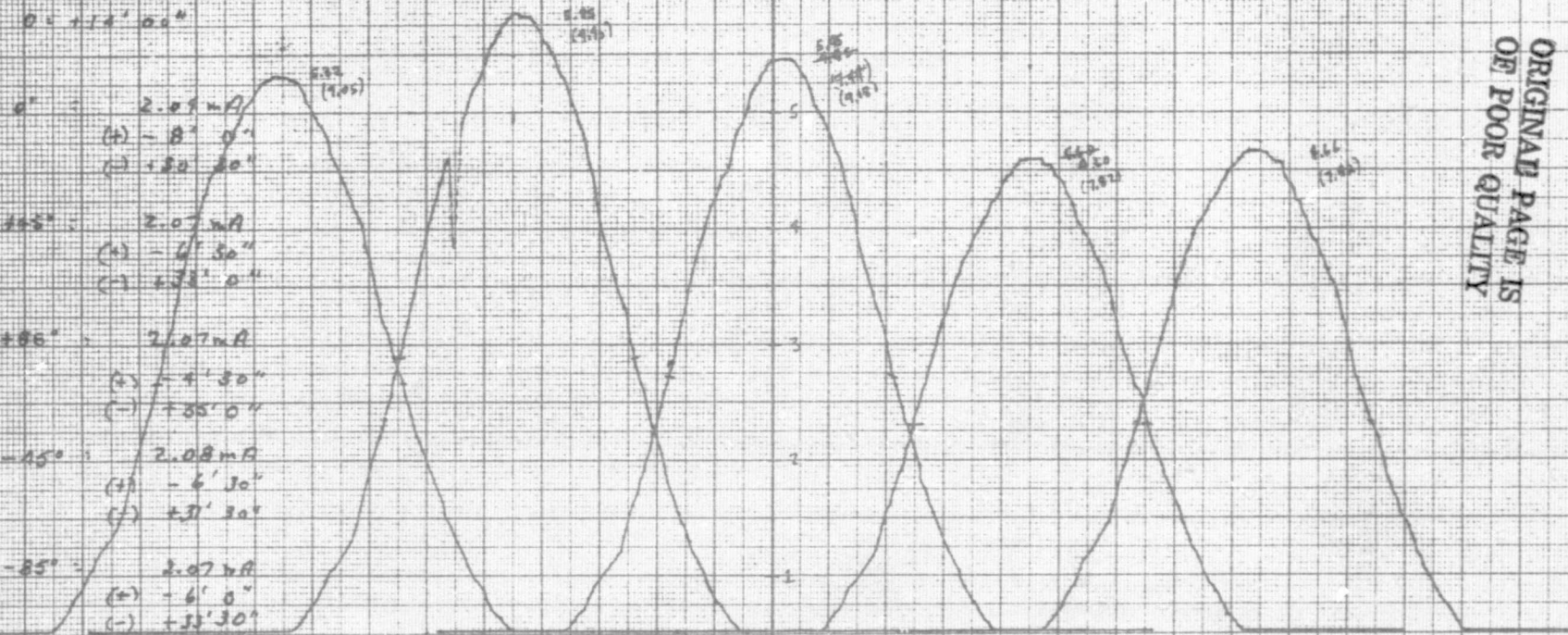
0° = 2.07 mA  
(+) - 8' 00"  
(-) + 8' 00"

+35° = 2.07 mA  
(+) - 6' 30"  
(-) + 3' 30"

+80° = 2.07 mA  
(+) - 4' 30"  
(-) + 55' 00"

+150° = 2.08 mA  
(+) - 6' 30"  
(-) + 3' 30"

-35° = 2.07 mA  
(+) - 6' 30"  
(-) + 3' 30"



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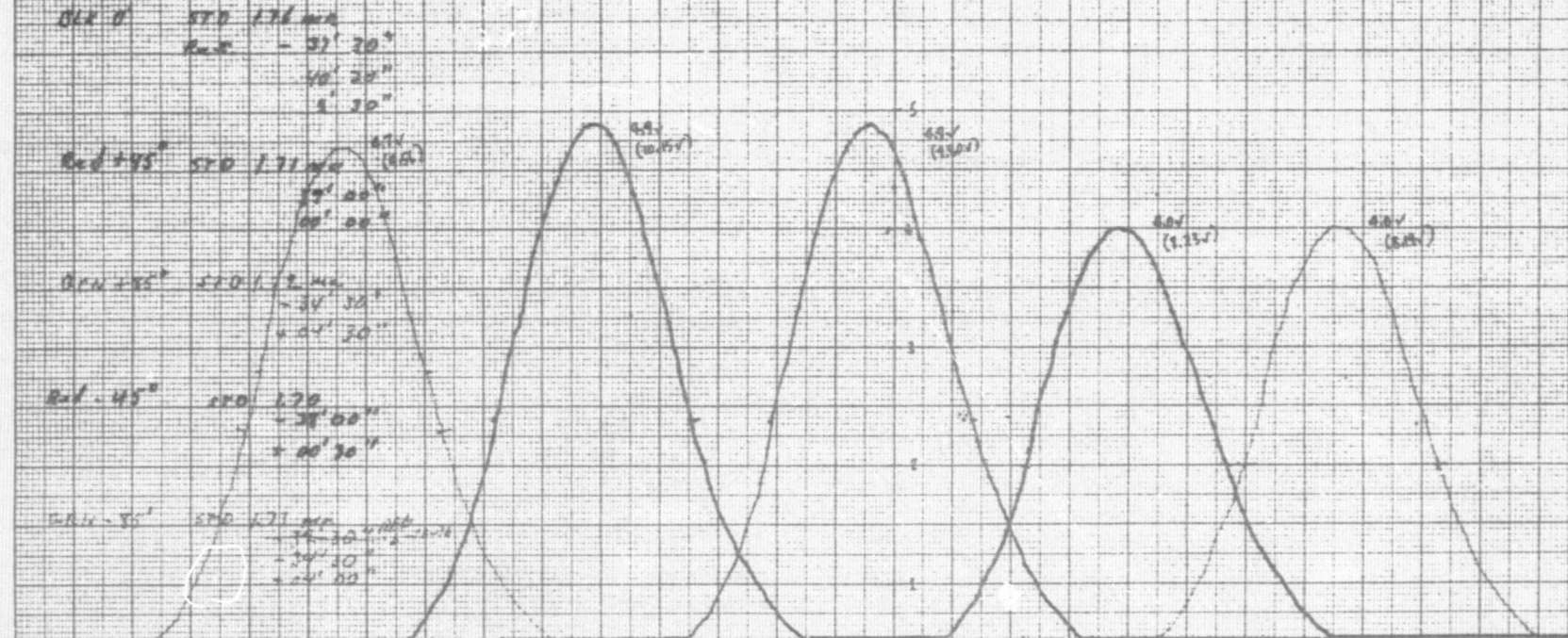
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# SENSOR DATA BLOCK

2-7

|                                            |               |
|--------------------------------------------|---------------|
| BLOCK S/N: 002                             | DATE: 8-16-76 |
| SENSOR: 55 R-TEST POST 2 <sup>nd</sup> VAP |               |
| DESC:                                      |               |
| TEMP: 21.1/16.7                            |               |
| SENSOR PEAK:                               |               |
| SOLAR PEAK:                                |               |
| SPACE PEAK:                                |               |
| SPACE GAIN: 10 <sup>2</sup> /div           |               |
| X FULL SCALE: 10 <sup>2</sup> /div         |               |



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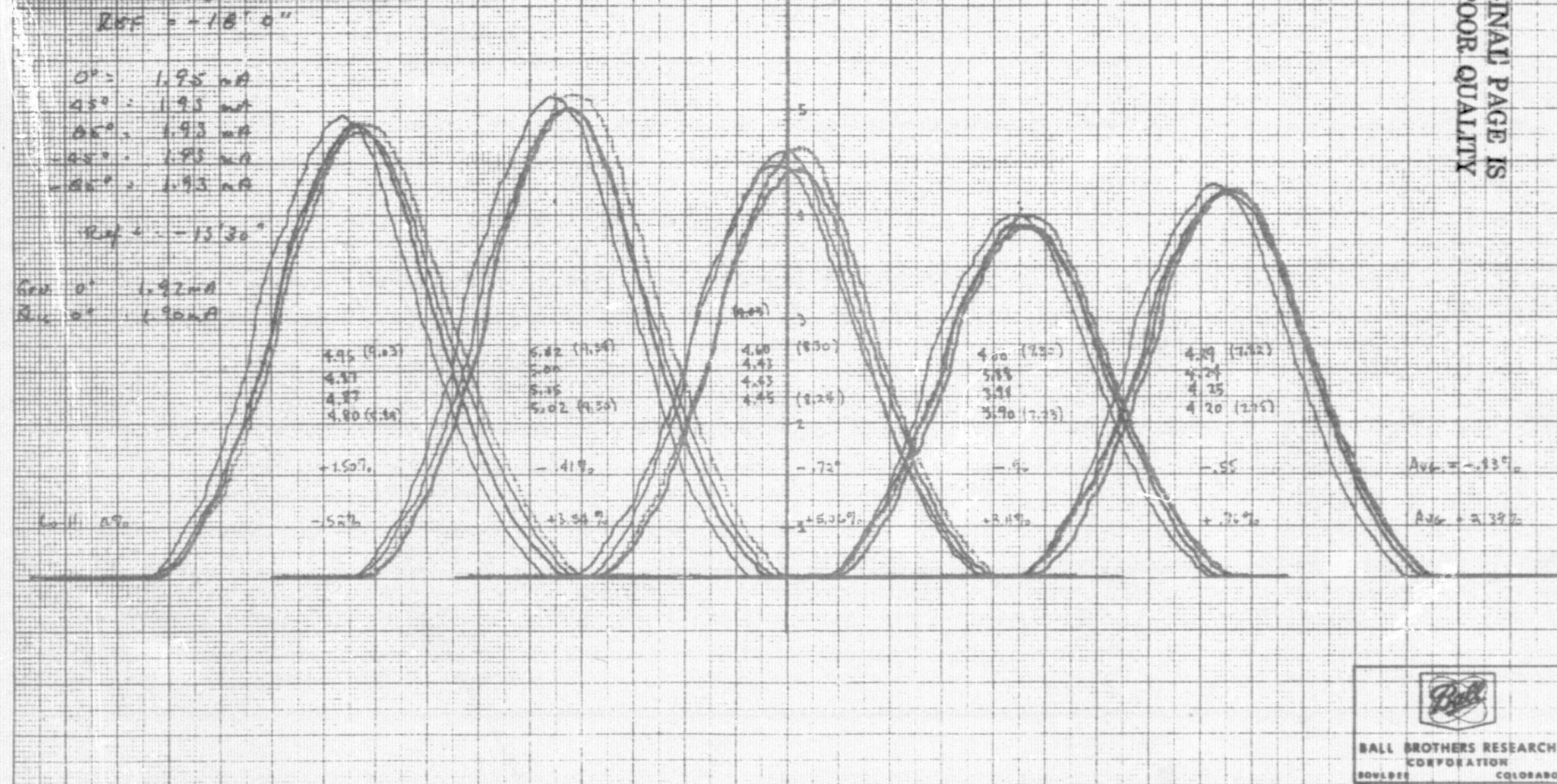
# SENSOR DATA BLOCK

Z-8

|                                    |                      |
|------------------------------------|----------------------|
| BLOCK S/N: 002                     | DATE: 9/1/76         |
| SENSOR: PAS                        |                      |
| DESC: RETEST PER MDZ A30194        |                      |
| APPROX. SET ASSEMBLY TORQUES TEMP: |                      |
| SENSOR PEAK:                       |                      |
| SOLAR PEAK:                        |                      |
| SPACE PEAK:                        |                      |
| SPACE GAIN: NULL                   |                      |
| X FULL SCALE SW/100                | Y FULL SCALE: 1V/100 |

TORQUES -  
 PLK = 6 ± 2.5  
 RED = 6 ± 1.0  
 GRN = 6 ± 4.0  
 BLU = 6 ± 2.5

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## 2-9

TORONTO FILE = 65-6037  
RED = Report re Toronto  
GRN = 1200 Reassigned H/L  
BLU = 1325 - WU Δ  
from Grn.



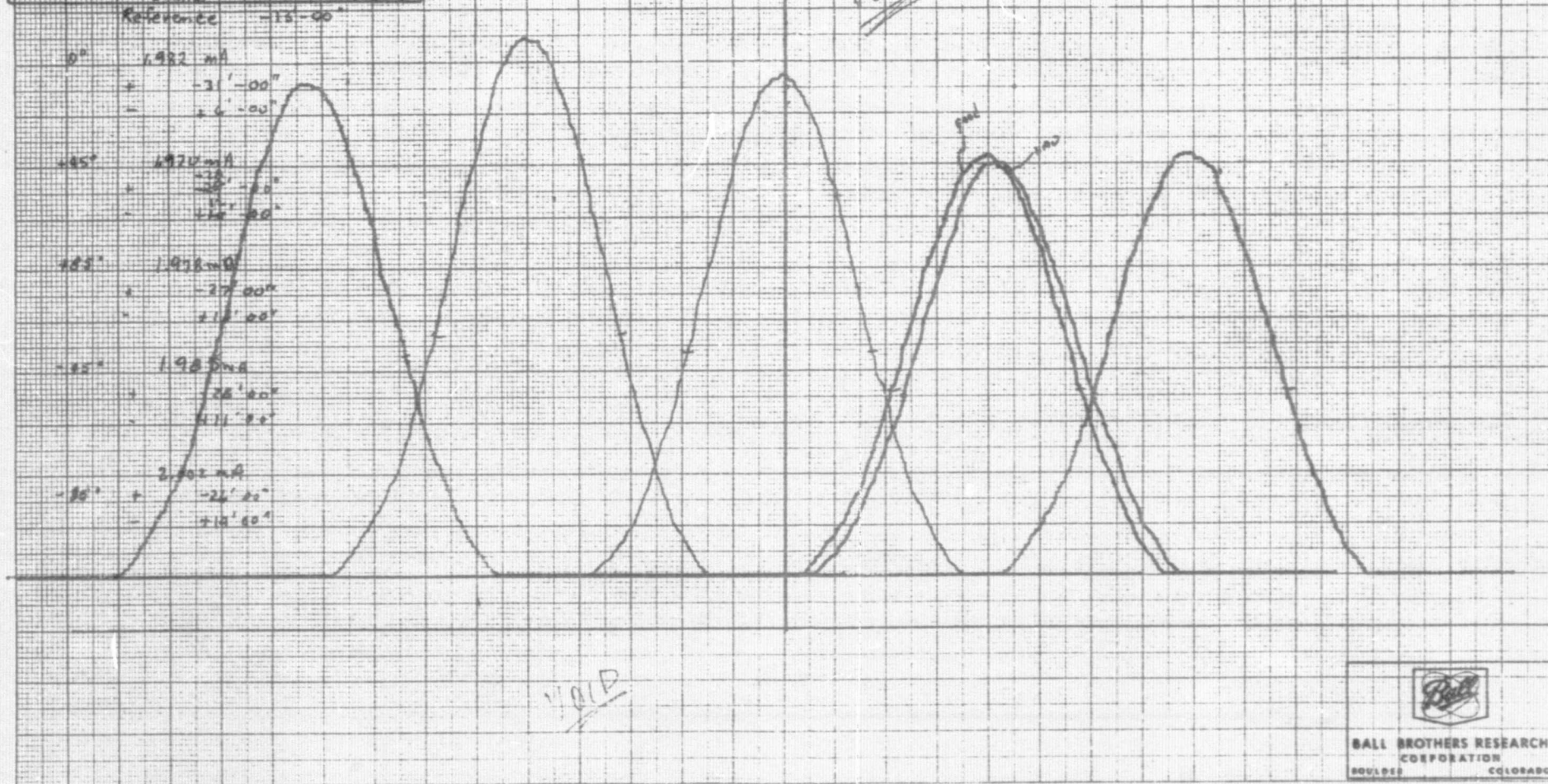


# SENSOR DATA BLOCK

2-10

|                             |                     |
|-----------------------------|---------------------|
| BLOCK S/N: 002              | DATE: 9/1/76        |
| SENSOR: MAS                 |                     |
| DESC: Retest For MDE A30198 |                     |
| TEMP:                       |                     |
| SENSOR PEAK:                |                     |
| SOLAR PEAK:                 |                     |
| SPACE PEAK:                 |                     |
| SPACE GAIN:                 | NULL:               |
| X FULL SCALE: 500/IN        | Y FULL SCALE: 1V/IN |

VOID

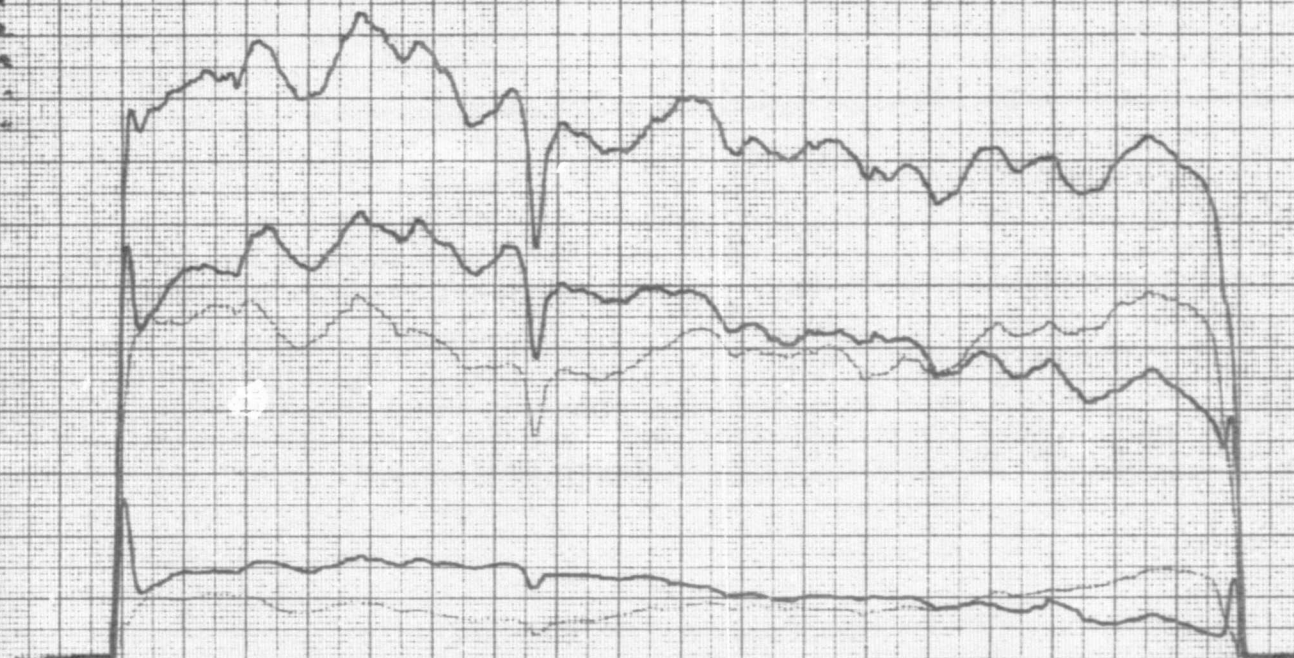


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## 2-11

|               |        |
|---------------|--------|
| $0^\circ$ STD | 1.89 m |
| $+15^\circ$   | 1.90 m |
| $+30^\circ$   | 1.87 m |
| $-15^\circ$   | 1.89 m |
| $-30^\circ$   | 1.87 m |



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# SENSOR DATA BLOCK

2-12

|                             |                      |
|-----------------------------|----------------------|
| BLOCK S/N: 002              | DATE: 7/27/76        |
| SENSOR: PAS                 | P. 8.16.3            |
| DESC: RETEST S.S. ELEVATION |                      |
| TEMP:                       |                      |
| SENSOR PEAK:                |                      |
| SOLAR PEAK:                 |                      |
| SPACE PEAK:                 |                      |
| SPACE GAIN: NULL            |                      |
| X FULL SCALE: 10/100        | Y FULL SCALE: 14/100 |

Ref. 16.80

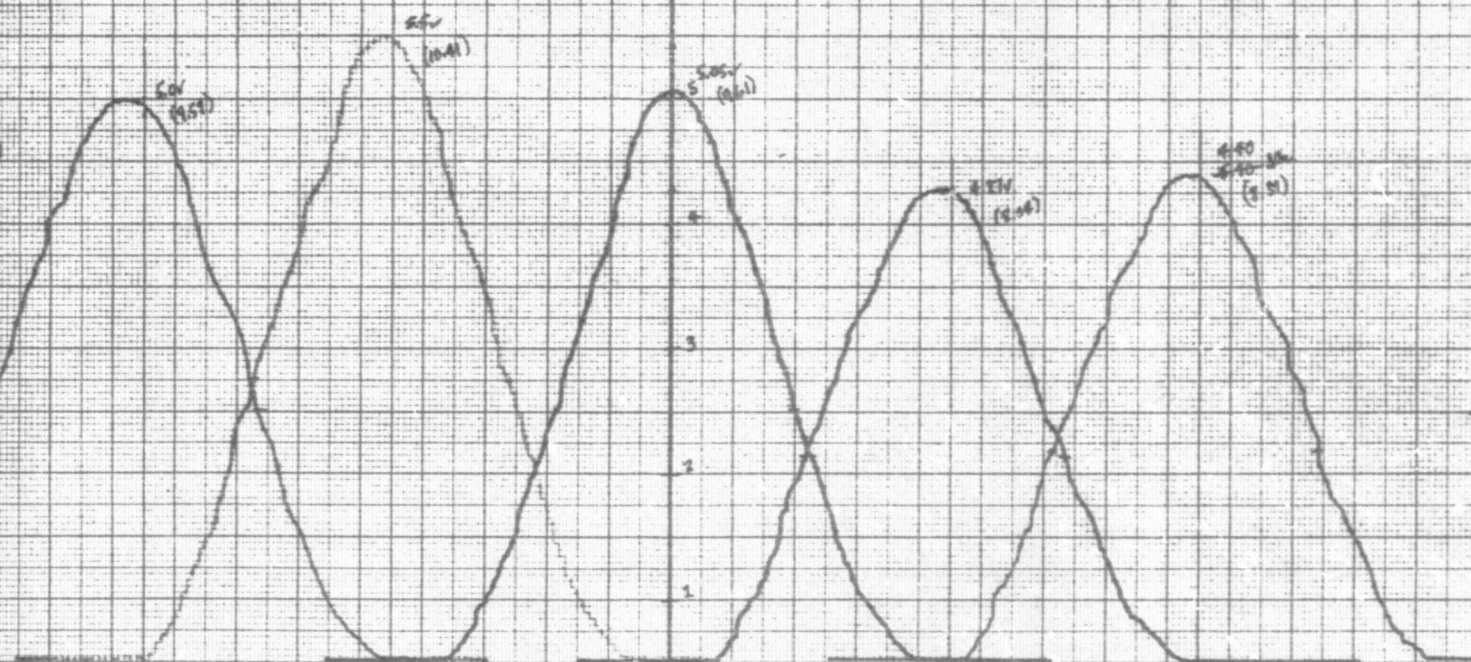
0° 1.55 mA  
 - (6° - 30°)  
 + (4° - 0°)

+35° 1.87 mA  
 - (5° - 30°)  
 + (4° - 30°)

+85° 1.85 mA  
 - (4° - 0°)  
 + (4° - 30°)

-45° 1.86 mA  
 - (5° - 80°)  
 + (4° - 30°)

-85° 1.84 mA  
 - (5° - 30°)  
 + (4° - 30°)



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NO. 10 X 10 TO 1/2 INCH 471323  
 GAIL BROTHERS RESEARCH CORPORATION  
 BOULDER, COLORADO



# SENSOR DATA BLOCK

2-13

|                                         |               |
|-----------------------------------------|---------------|
| BLOCK S/N: 002                          | DATE: 7-27-76 |
| SENSOR: PAS                             | 8415.9        |
| DESC: SUN SPLIT AZIMUTH                 | RETEST        |
| TEMP:                                   |               |
| SENSOR PEAK:                            |               |
| SOLAR PEAK:                             |               |
| SPACE PEAK:                             |               |
| SPACE GAIN: NULL                        |               |
| X FULL SCALE: 150° Y FULL SCALE: 100 IN |               |

IF IN - CALIBRATION  
AS APPLIED - 2400 X 100  
USING FULLY AND FULLY  
THANK U

BLK 0° Sun Peak 1.52 mV

+25° 1.92 mV  
 +20° 1.83 "  
 +15° 1.74 "  
 +10° 1.64 "

-5° 1.84 "  
 -10° 1.74 "  
 -15° 1.65 "  
 -20° 1.54 "



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DOC NO 49959

DATE

CODE IDENT NO 13993

SHEET

54

REV

**Data Sheet 1**

Paragraph numbers correspond with paragraph numbers of Test Procedure, Performance-Panoramic Attitude Sensor, 49959.

**3.2 SERIAL NUMBER**

- Scanner head serial number 003
- Main Electronics serial number 003

**3.3 TEST OPERATOR**

- Signature of test operator Stan Mueh
- Date of start of test 8/5/76
- Date of end of test 8/6/76

**3.4 EQUIPMENT REQUIRED**

- Visicorder, Honeywell 1508, S/N B5401, Cal. Due N/A
- High Voltage Power Supply, Fluke 301C or equivalent  
— S/N B9808
- Oscilloscope with camera, Tektronix ~~547~~ or equivalent  
7633 S/N C-9002, Cal. date 11/17/76
- Current probe, Tektronix P6042 or equivalent —,  
S/N C-8221, Cal. date 1/8/77
- DVM, H-P ~~3440~~ or equivalent HP3465A, S/N C-9255,  
Cal. date 1/1/77
- Current Meter, Weston 911 or equivalent —,  
S/N B-3217, Cal. date 11/11/76
- VOM, Simpson 270 or equivalent HP 3465A,  
S/N C-9130, Cal. date 11/10/76
- Precision power supply, H-P 6114A or equivalent —,  
S/N C-8792, Cal. date 1/22/77
- Pulse generator, Tektronix 2102 or equivalent —,  
S/N C8226, Cal. date 11/5/76
- X-Y Plotter, H-P 7047A or equivalent —,  
S/N C-9047, Cal. date 11/19/76
- Dividing Head, 2 axis, Leitz Imperial Series 72 or  
equivalent —, S/N B-12611, Cal. date 1/12/77

8/10/76  
501  
100

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BOULDER, COLORADO 80302

DOC NO 49959

DATE \_\_\_\_\_

CODE IDENT NO 13993

SHEET 55 REV \_\_\_\_\_**Data Sheet 2**

3.6.1 Self Check

Check ☒

3.6.2 Test Set Supply Voltages

| <u>FUNCTION</u> | <u>MEASUREMENT</u> | <u>REQUIREMENT</u> |
|-----------------|--------------------|--------------------|
| +28v            | <u>0.68</u> mA     | 0.7 + 0.07         |
| +12v            | <u>0.61</u> mA     | 0.6 + 0.06         |
| +10v            | <u>0.48</u> mA     | 0.5 + 0.05         |
| + 8v            | <u>0.82</u> mA     | 0.8 + 0.08         |
| + 5v            | <u>0.50</u> mA     | 0.5 + 0.05         |
| - 5v            | <u>0.53</u> mA     | 0.5 + 0.05         |

4.1.1 Ground Continuity

| <u>Measure from<br/>Pin to Pin</u> | <u>Function</u> | <u>Measurement</u> | <u>Requirement</u> |
|------------------------------------|-----------------|--------------------|--------------------|
| 20 Electronics box chassis         | CHASSIS GND.    | <u>0.07</u> Ohm    | <0.2 Ohms          |
| 20 21                              | CHASSIS GND.    | <u>0.06</u> Ohm    | <0.2 Ohms          |
| 17 19                              | 28v Ret.        | <u>0.18</u> Ohm    | <0.2 Ohms          |
| 12 13                              | SIG. CND.       | <u>0.17</u> Ohm    | <0.2 Ohms          |

4.1.2 Ground Isolation

| <u>Measure from<br/>Pin to Pin</u> | <u>Function</u> | <u>Measurement</u> | <u>Requirement</u> |
|------------------------------------|-----------------|--------------------|--------------------|
| 20 12                              | SIG. GND.       | <u>&gt;10M</u> Ohm | >100 kΩ            |
| 20 17                              | 28v Ret.        | <u>&gt;10M</u> Ohm | >100 kΩ            |

4.2.1 Thermistor Continuity

| <u>Measure from<br/>Pin to Pin</u> | <u>Function</u>                   | <u>Measurement</u> | <u>Requirement</u> |
|------------------------------------|-----------------------------------|--------------------|--------------------|
| 14 15                              | Elect. Thms. 1(R <sub>et1</sub> ) | <u>11.07</u> kΩ    | 5k to 15kΩ         |
| 33 34                              | Elect. Thms. 2(R <sub>et2</sub> ) | <u>11.06</u> kΩ    | 5k to 15kΩ         |
| 35 36                              | Scan. Thms. 1(R <sub>st1</sub> )  | <u>11.12</u> kΩ    | 5k to 15kΩ         |
| 37 5                               | Scan. Thms. 2(R <sub>st2</sub> )  | <u>11.13</u> kΩ    | 5k to 15kΩ         |





## Data Sheet 3

## 4.2.2 Electronics Thermistor Resistance

$$\Delta R = \frac{(R_{et1} - R_{et2}) \times 100\%}{R_{et1}} = \frac{(11.07 \text{ k}\Omega - 11.06 \text{ k}\Omega) \times 100\%}{11.07 \text{ k}\Omega}$$

$$R_{et1} = 0.09 \%$$

Requirement:  $\pm 4\%$ 

## 4.2.3 Scanner Thermistor Resistance

$$\Delta R = \frac{(R_{st1} - R_{st2}) \times 100\%}{R_{st1}} = \frac{(11.12 \text{ k}\Omega - 11.13 \text{ k}\Omega) \times 100\%}{11.12 \text{ k}\Omega}$$

$$R_{st1} = 0.09 \%$$

Requirement:  $\pm 4\%$ 

## 4.2.4 Thermistor Isolation

| Measure from<br>Pin to Pin |    | Function       | Measurement                 | Requirement     |
|----------------------------|----|----------------|-----------------------------|-----------------|
| 14                         | 20 | Elect. Thms. 1 | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 34                         | 20 | Elect. Thms. 2 | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 35                         | 20 | Scan. Thms. 1  | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 37                         | 20 | Scan. Thms. 2  | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |

## 4.3.3 Initial Turn On

Check ☒

## 4.4.3 Idle Input Current

| Function                          | Measurement    | Requirement     |
|-----------------------------------|----------------|-----------------|
| 28v input current<br>( $I_{in}$ ) | <u>42.5</u> mA | 50mA $\pm$ 25mA |
| 28v input voltage<br>( $E_{in}$ ) | <u>28.07</u> V | 28V $\pm$ 0.28V |

## 4.4.4 Idle Input Power

$$P_i = E_{in} \times I_{in}$$

$$= 28.07 \text{ V} \times 42.5 \text{ mA}$$

$$= 1193 \text{ mW. Reference reading only.}$$

15  
8/10/76  
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## Data Sheet 4

4.4.6 Scanner Rotation

Check ☒

4.4.7 Running Power

FunctionMeasurement28v input current  
( $I_{in}$ )155 mA

Reference only

28v input voltage  
( $E_{in}$ )28.02 V

Reference only

$$P_r = E_{in} \times I_{in}$$

$$= 28.02 \text{ V} \times 155 \text{ mA}$$

$$= 4343 \text{ mW}$$

Requirement

&lt;5.0 watts

4.4.11 Main Electronics Power

FunctionMeasurement28v input current  
( $I_{in}$ )24.9 mA

Reference only

28v input voltage  
( $E_{in}$ )28.05 V

Reference only

$$P_e = E_{in} \times I_{in}$$

$$= 28.05 \text{ V} \times 24.9 \text{ mA}$$

$$P_e = 698.5 \text{ mW}$$

Requirement

&lt;1.0 watts

4.5 Power On Initialize

4.5.3 ☒ Check4.5.5 ☒ Check

$$4.5.7 \quad \text{OFFSET} = \frac{\text{AOS1} + \text{LOS1} + \text{AOS2} + \text{LOS2} + \text{AOS3} + \text{LOS3} - 1060}{6}$$

15      19      126      132      384      389

$$\text{OFFSET} = \underline{0.8}$$

Requirement: + 34.5.8 ☒ Check4.5.9 ☒ Check



**Data Sheet 5****4.6.1 Analog Telem Calibration**

| <u>Measure from</u><br><u>Pin to Pin</u> |    | <u>Function</u> | <u>Measurement</u> | <u>Requirement</u> |
|------------------------------------------|----|-----------------|--------------------|--------------------|
| 12                                       | 9  | + 5v MONITOR    | <u>4.166</u> V     | 4.0 + 1.0V         |
| 12                                       | 10 | +20v MONITOR    | <u>4.072</u> V     | 4.0 ± 1.0V         |

**4.7.2 Scanner Revolution Rate**

| <u>Rate (R)</u> | <u>Rate Readout</u> | <u>Measured Time</u> | <u>Nominal Time</u> |
|-----------------|---------------------|----------------------|---------------------|
| 0               | <u>0</u>            | <u>52</u> sec.       | 52 sec.             |
| 1               | <u>1</u>            | <u>26</u> sec.       | 26 sec.             |
| 2               | <u>2</u>            | <u>13</u> sec.       | 13 sec.             |
| 3               | <u>3</u>            | <u>6.5</u> sec.      | 6.5 sec.            |

**4.8 Invalid Data Test**4.8.1 ✓ Check4.8.2 ✓ Check**4.9 CW-CCW Test**4.9.2 ✓ Check4.9.4 ✓ Check4.9.5 ✓ Check4.9.6 ✓ Check4.9.7 ✓ Check**4.10 Sector Test**4.10.2 ✓ Check4.10.3 ✓ Check4.10.4 ✓ Check4.10.5 ✓ Check4.10.6 ✓ Check4.10.7 ✓ Check4.10.8 ✓ Check4.10.9 ✓ Check4.10.10 ✓ Check*8/10/76*  
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## Data Sheet 6

|         |          |       |
|---------|----------|-------|
| 4.10.11 | <u>✓</u> | Check |
| 4.10.12 | <u>✓</u> | Check |
| 4.10.13 | <u>✓</u> | Check |
| 4.10.14 | <u>✓</u> | Check |
| 4.10.15 | <u>✓</u> | Check |
| 4.10.16 | <u>✓</u> | Check |
| 4.10.17 | <u>✓</u> | Check |
| 4.10.18 | <u>✓</u> | Check |
| 4.10.19 | <u>✓</u> | Check |
| 4.10.20 | <u>✓</u> | Check |
| 4.10.21 | <u>✓</u> | Check |
| 4.10.22 | <u>✓</u> | Check |
| 4.10.23 | <u>✓</u> | Check |
| 4.10.24 | <u>✓</u> | Check |
| 4.10.25 | <u>✓</u> | Check |
| 4.10.26 | <u>✓</u> | Check |
| 4.10.27 | <u>✓</u> | Check |
| 4.10.28 | <u>✓</u> | Check |
| 4.10.29 | <u>✓</u> | Check |
| 4.10.30 | <u>✓</u> | Check |
| 4.10.31 | <u>✓</u> | Check |
| 4.10.32 | <u>✓</u> | Check |
| 4.10.33 | <u>✓</u> | Check |
| 4.10.34 | <u>✓</u> | Check |
| 4.10.35 | <u>✓</u> | Check |
| 4.10.36 | <u>✓</u> | Check |
| 4.10.37 | <u>✓</u> | Check |

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*13*



## Data Sheet 7

4.11.6 Sector Check

Check ☒

4.11.7 Power Supply Variation

POWER  
SUPPLYAOS/LOS  
DISPLAY0  
READOUT

26.60 + 0.26v (-4%)

☒☒

28.84 + 0.28v (+2%)

☒☒

28.60 + 0.28v (NOM)

☒☒

4.11.9 Clock Frequency Variations

Frequency at FailureRequirement

Upper 19.87 MHz

&gt;12.9 MHz

Lower &lt;5.0 MHz

&lt;10.0 MHz

4.12 Slow Data Rate

4.12.5 ☒ Check4.12.6 ☒ Check4.12.7 ☒ Check4.12.8 ☒ Check4.12.9 ☒ Check4.12.10 ☒ Check4.12.11 ☒ Check4.12.12 ☒ Check

4.13 Spherical Mode Check

4.13.4 ☒ Check4.13.5 ☒ Check4.13.6 ☒ Check4.13.7 ☒ Check4.13.8 ☒ Check4.13.9 ☒ Check4.13.10 ☒ Check



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Data Sheet 8

|         |                |
|---------|----------------|
| 4.13.11 | <u>✓</u> Check |
| 4.13.12 | <u>✓</u> Check |
| 4.13.13 | <u>✓</u> Check |
| 4.13.14 | <u>✓</u> Check |
| 4.13.15 | <u>✓</u> Check |
| 4.13.16 | <u>✓</u> Check |
| 4.13.17 | <u>✓</u> Check |
| 4.13.18 | <u>✓</u> Check |
| 4.13.19 | <u>✓</u> Check |
| 4.13.20 | <u>✓</u> Check |
| 4.13.21 | <u>✓</u> Check |
| 4.13.22 | <u>✓</u> Check |
| 4.13.23 | <u>✓</u> Check |
| 4.13.24 | <u>✓</u> Check |
| 4.13.25 | <u>✓</u> Check |
| 4.13.26 | <u>✓</u> Check |
| 4.13.27 | <u>✓</u> Check |
| 4.13.28 | <u>✓</u> Check |
| 4.13.29 | <u>✓</u> Check |
| 4.13.30 | <u>✓</u> Check |
| 4.13.31 | <u>✓</u> Check |
| 4.13.32 | <u>✓</u> Check |
| 4.13.33 | <u>✓</u> Check |
| 4.13.34 | <u>✓</u> Check |
| 4.13.35 | <u>✓</u> Check |
| 4.13.36 | <u>✓</u> Check |

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Data Sheet 9

ORIGINAL PAGE IS  
OF POOR QUALITY

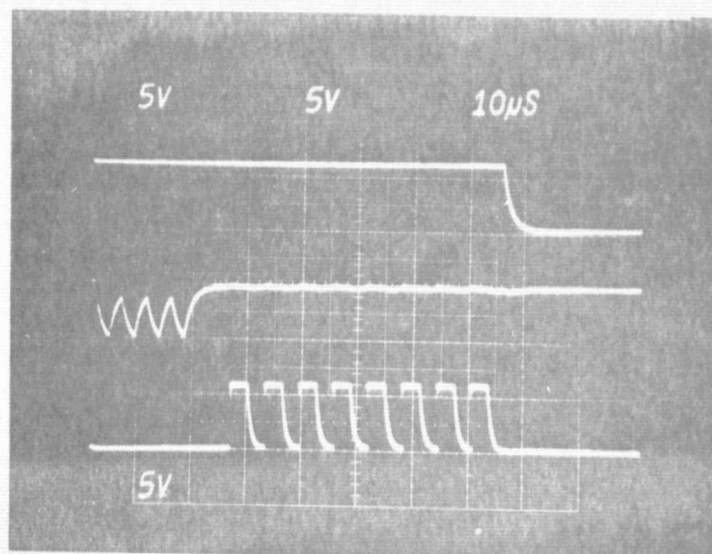
4.14.2

2v/cm

2v/cm

2v/cm

10 $\mu$ s/cm



DWG

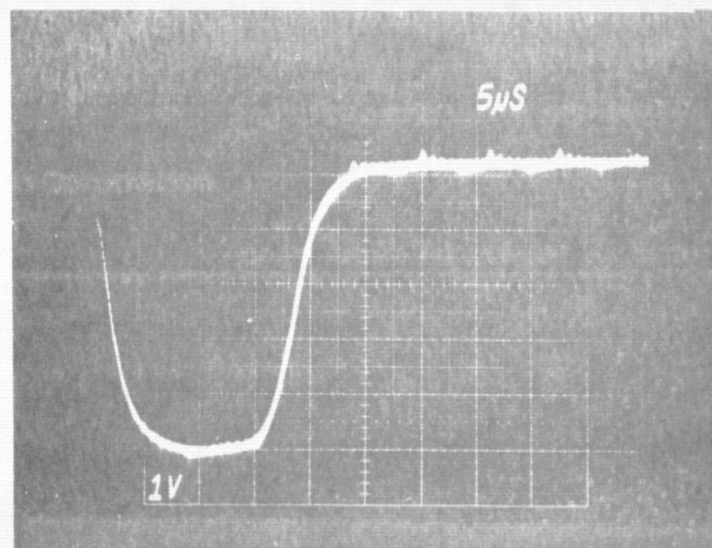
Burst  
Clock

Shift  
Pulses

4.14.6

1v/cm

5 $\mu$ s/cm



Load  
Pulse

13  
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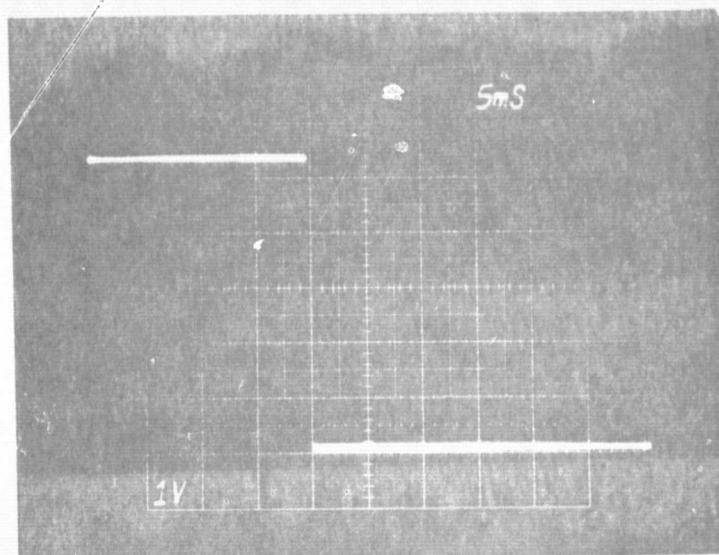
Data Sheet 10

ORIGINAL PAGE IS  
OF POOR QUALITY

4.14.11

1v/cm

5ms/cm

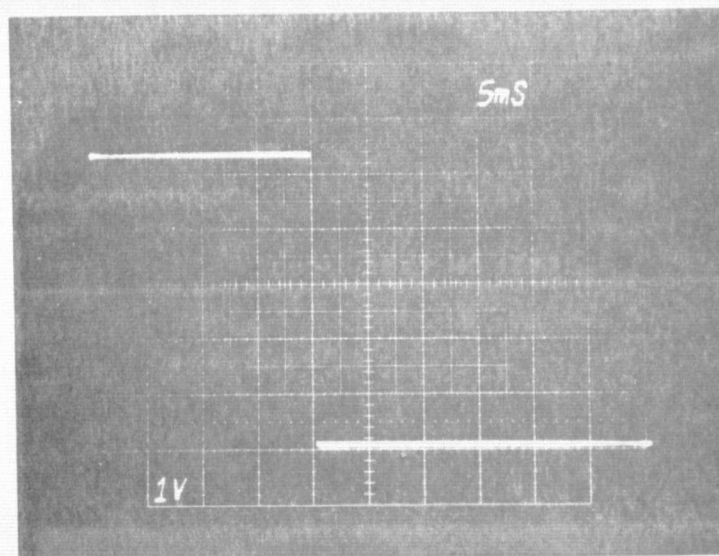


Sun  
Slit  
#1

4.14.14

1v/cm

5ms/cm



Sun  
Slit  
#2

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13



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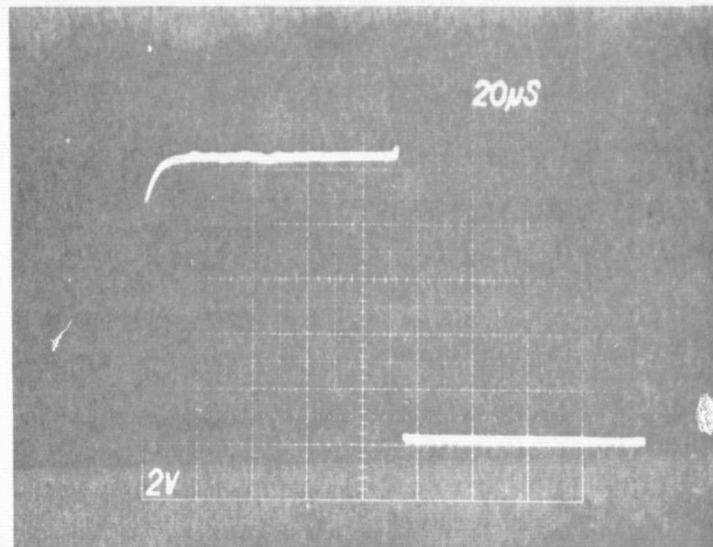
DOC NO 49959  
DATE

Data Sheet 11

4.14.17

2v/cm

20ms/cm



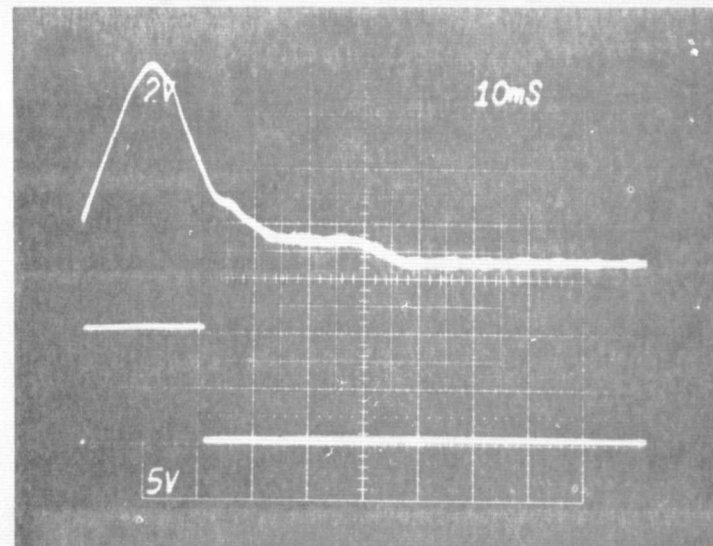
10v  
Sun  
Pulse

4.14.21

2v/cm

5v/cm

10ms/cm



Sun  
Slit  
Analog

Sun  
Slit

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1.5V  
22.1





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### Data Sheet 12

#### 4.14.22 Sun Slit Amplitude

$V_{pk} = \underline{7.6}$  volts

Reference only

$\frac{V_{pk}}{2} = \frac{7.6}{2} = \underline{3.8}$  volts

Reference only

#### 4.14.23 Sun Slit Failure Edge

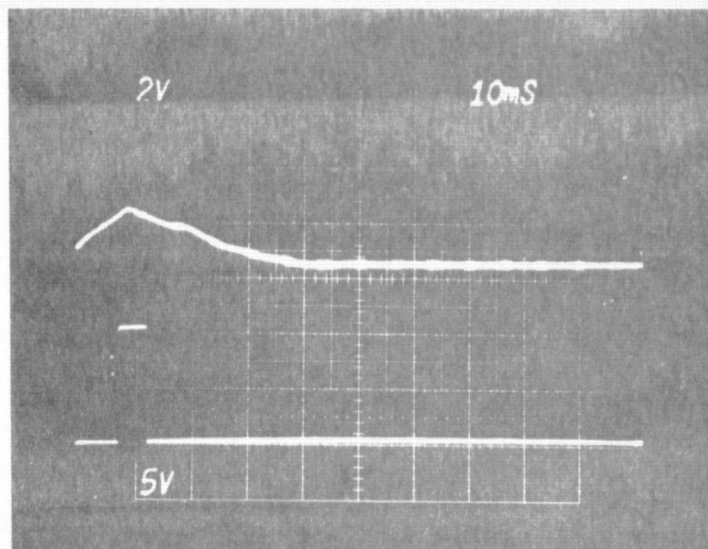
3.8 Volts, Requirement:  $\frac{V_{pk}}{2} \pm 0.5V$

#### 4.14.24 Minimum Threshold Photo

2v/cm

5v/cm

10.43 / cm  
5ms/cm



Sun Slit  
Analog

Sun  
Slit

#### 4.14.25 Minimum Threshold Measurement

2.3 Volts, Requirement  $2.25 \pm 0.5V$

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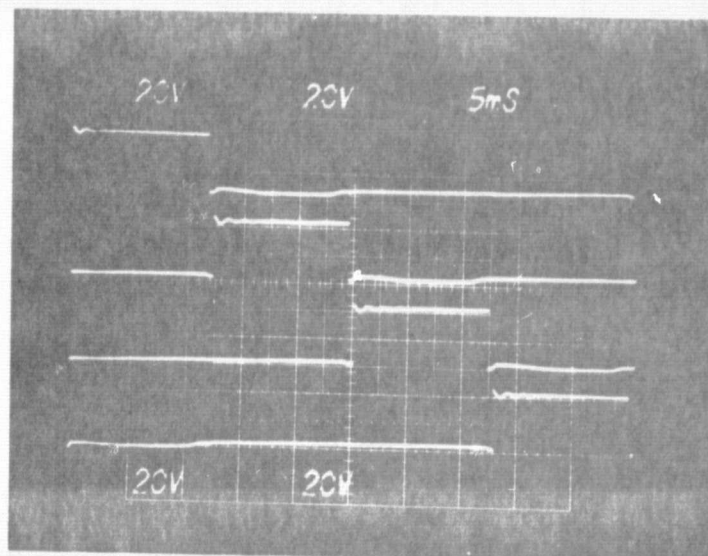
Data Sheet 13

4.14.28 Motor Drive Pulses

ORIGINAL PAGE IS  
OF POOR QUALITY

20v/cm

5ms/cm



$\Phi A$

$\Phi B$

$\Phi C$

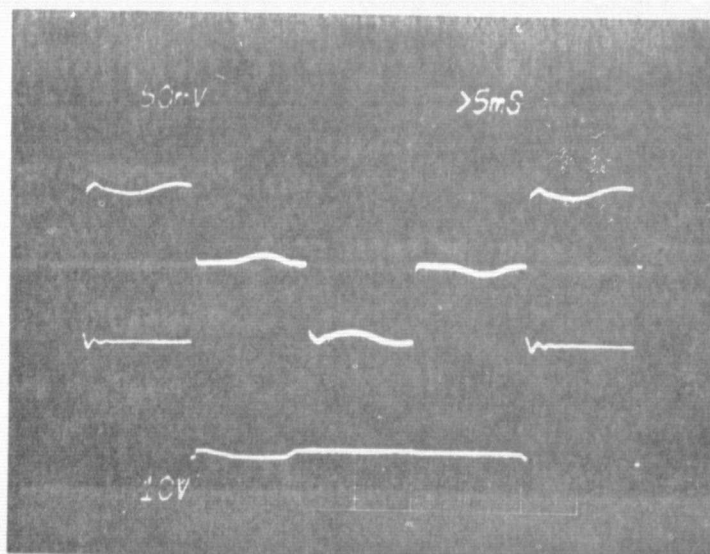
$\Phi D$

4.14.33  $\Phi A$  Current Photograph

100mA/cm

10v/cm

$\sim 6ms/cm$



$\Phi A$  motor  
current

$\Phi A$  motor  
voltage

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13  
RMC







Data Sheet 14

4.14.3<sup>r</sup>  $\Phi$ A Current Measurement

Measurement

280 mA

Requirement

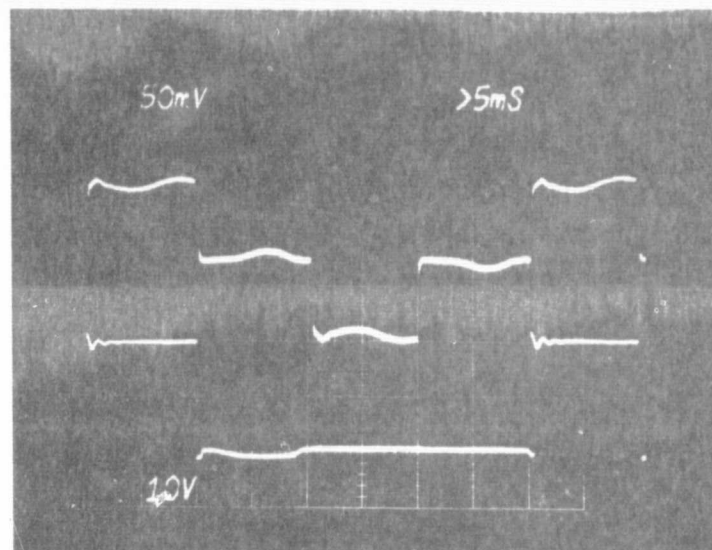
300 mA max excluding spikes

4.14.37  $\Phi$ B Current Photograph

100mA/cm

10v/cm

6ms/cm



$\Phi$ A motor  
voltage

$\Phi$ B motor  
current

4.14.38  $\Phi$ B Current Measurement

Measurement

285 mA

Requirement

300 mA max excluding spikes





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### Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt Angle (degrees) | Peak Amplitude (volts) | (1)<br>-Az Angle at 1/2 PK Amp (degrees) | (2)<br>+Az Angle at 1/2 PK Amp (degrees) |
|----------------------|------------------------|------------------------------------------|------------------------------------------|
| +1.00                | —                      | —                                        | —                                        |
| 0.75                 | —                      | —                                        | —                                        |
| 0.50                 | 0.90                   | -90°                                     | +91°                                     |
| 0.25                 | 3.00v.                 | -90°                                     | +91°                                     |
| 0.0                  | 5.50v.                 | -90°                                     | +90°                                     |
| -0.25                | 4.75v.                 | -90°                                     | +90°                                     |
| -0.50                | 2.10v.                 | -90°                                     | +91°                                     |
| -0.75                | —                      | —                                        | —                                        |
| -1.00                | —                      | —                                        | —                                        |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

✓ Check



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### Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table.

| Azimu-<br>Azimuth<br>Angle<br>(degrees) | Space Corrected<br>Peak<br>Amplitude<br>(volts) | (1)<br>-Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | F.O.V. |
|-----------------------------------------|-------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------|
| -90-85°                                 | 8.80v.                                          | $\epsilon^- = -0.425$                            | $\epsilon^+ = 0.250$                             | 0.68   |
| -45                                     | 10.11v.                                         | $\epsilon^- = -0.333$                            | $\epsilon^+ = 0.292$                             | 0.63   |
| 0                                       | 9.74v.                                          | $\epsilon^- = -0.275$                            | $\epsilon^+ = 0.358$                             | 0.63   |
| +45                                     | 9.63v.                                          | $\epsilon^- = -0.342$                            | $\epsilon^+ = 0.267$                             | 0.61   |
| 90+85°                                  | 8.43v.                                          | $\eta^- = -0.383$                                | $\eta^+ = 0.267$                                 | 0.65   |

The sun sensor field of view (|column 1 - column 2|) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

Check

See MDR #A30291

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\epsilon^- + \epsilon^+)}{2}$$

$$= 0.042^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(\epsilon^+ + \epsilon^- + \eta^- + \eta^+)}{4}$$

$$= 0.015^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling edge trip point offset  $0.36^\circ$

Reference Only



## Data Sheet 17

4.16.7

- Transcribe the 2-axis table settings and complete the following table and calculate the Azimuth Field of View (FOV = | column 4 - column 3 |).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Azimuth Angle<br>1/2 Pk. Amp. | Positive<br>Azimuth Angle<br>1/2 Pk. Amp. | Azimuth<br>FOV*                 | Require-<br>ment |
|--------------------------------|--------------------|-------------------------------------------|-------------------------------------------|---------------------------------|------------------|
| 000                            | 0° (x-axis)        | $\alpha_1 = -0.416$                       | $\alpha_2 = 0.269$                        | $ \alpha_2 - \alpha_1  = 0.685$ | 0.71 ± 0.05°     |
| 128                            | 90°                | $\beta_1 = -0.370$                        | $\beta_2 = 0.295$                         | $ \beta_2 - \beta_1  = 0.665$   | 0.71 ± 0.05°     |
| 256                            | 180°               | $\gamma_1 = -0.370$                       | $\gamma_2 = 0.314$                        | $ \gamma_2 - \gamma_1  = 0.684$ | 0.71 ± 0.05°     |
| 384                            | 270° (y-axis)      | $\delta_1 = -0.387$                       | $\delta_2 = 0.298$                        | $ \delta_2 - \delta_1  = 0.684$ | 0.71 ± 0.05°     |

\* The scanner Field of View shall be 0.71° ± 0.05° at 50% of the peak amplitude.

- Calculate the Zero Scan Angle Error using the following equation:

$$\text{Error} = \frac{|\alpha_2 + \alpha_1|}{2}$$

$$\text{Error} = 0.074^\circ$$

Requirement

$$0^\circ \pm 0.7^\circ$$

- Calculate the scanner position accuracy according to the equations below:

| Encoder<br>Position | Reference<br>Angle | Error                                                          | Requirement |
|---------------------|--------------------|----------------------------------------------------------------|-------------|
| 128                 | 90°                | $(\alpha_1 + \alpha_2 - \beta_1 - \beta_2)/2 = -0.036^\circ$   | ± 0.1°      |
| 256                 | 180°               | $(\alpha_1 + \alpha_2 - \gamma_1 - \gamma_2)/2 = -0.046^\circ$ | ± 0.1°      |
| 384                 | 270°               | $(\alpha_1 + \alpha_2 - \delta_1 - \delta_2)/2 = -0.029^\circ$ | ± 0.1°      |



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### Data Sheet 18

4.16.9

- Transcribe the 2-axis table readings to the following table and calculate the Elevation Field of View (FOV\* | column 4 - column 3 |).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Elevation<br>Angle<br>1/2 Pk. amp | Positive<br>Elevation<br>Angle<br>1/2 Pk. amp | Elevation<br>FOV*               | Require<br>ment |
|--------------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------|-----------------|
| 000                            | 0° (x-axis)        | $\alpha_- = 0.000$                            | $\alpha_+ = 0.683$                            | $ \alpha_+ - \alpha_-  = 0.683$ | 0.71±05°        |
| 128                            | 90°                | $\beta_- = -0.025$                            | $\beta_+ = 0.667$                             | $ \beta_+ - \beta_-  = 0.692$   | 0.71±05°        |
| 256                            | 180°               | $\gamma_- = -0.042$                           | $\gamma_+ = 0.658$                            | $ \gamma_+ - \gamma_-  = 0.100$ | 0.71±05°        |
| 384                            | 270° (y-axis)      | $\delta_- = -0.025$                           | $\delta_+ = 0.683$                            | $ \delta_+ - \delta_-  = 0.708$ | 0.71±05°        |

\*The scanner field of view shall be 0.71° ± 0.05° at 50% of the peak amplitude.

- Calculate the tilt angle ( $\phi$  in Figure 13) of the plane of the scanner optical axis with respect to the plane of the mounting surface using the following equation.

$$\phi = \tan^{-1} \left( \frac{|\sqrt{\alpha^2 + \beta^2 + \gamma^2 + \delta^2 - 2\alpha\gamma - 2\beta\delta}|}{2} \right)$$

where;  $\alpha = \tan (\alpha_+ + \alpha_-) / 2$

$\beta = \tan (\beta_+ + \beta_-) / 2$

$\gamma = \tan (\gamma_+ + \gamma_-) / 2$

$\delta = \tan (\delta_+ + \delta_-) / 2$

$\phi = 0.017^\circ$

Requirement

(0° + 2.0)

- Calculate the direction of maximum tilt response with respect to the zero reference angle ( $\theta$  in Figure 13) using the following equation:

$$\theta = \tan^{-1} \frac{(\delta - \beta)}{(\gamma - \alpha)} - \frac{(\delta - \beta)}{|\delta - \beta|} \frac{(\gamma - \alpha)}{|\gamma - \alpha|} \cdot 90^\circ - \frac{(\delta - \beta)}{|\delta - \beta|} \cdot 90^\circ + 180^\circ \quad \text{Reference only}$$

$\theta = 166^\circ$



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Date Sheet 19

- Calculate the cone angle (average deviation from a plane) using the following equation:

$$\phi = \frac{(\alpha_- + \alpha_+ + \beta_- + \beta_+ + \gamma_- + \gamma_+ + \delta_- + \delta_+)}{8}$$

$$\phi = \frac{0.33 \text{ defm}}{0.36} = 0.917 \text{ } ^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

- Calculate the maximum error using the following equation:

$$\text{error} = |\phi| + |\phi| = 0.34^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

#### 4.17.7 Backlash Test

Measured

$$0.10^\circ$$

Requirement

$$0.2^\circ \text{ max}$$

#### 4.16.13 Scanner Trip-On Point

Measured  $V_{\text{trip-on}}$

$$9.075 \text{ V}$$

Measured  $V_{\text{dark}}$

$$9.001 \text{ V}$$

$$\% \text{ full space mean} = \frac{V_{\text{trip-on}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 7.6\%$$

Requirement  
5% to 20%

#### 4.16.15 Scanner Trip-off Point

Measured  $V_{\text{trip-off}}$

$$9.071 \text{ V}$$

Measured  $V_{\text{dark}}$

$$9.001 \text{ V}$$

$$\% \text{ full space mean} = \frac{V_{\text{trip-on}} - V_{\text{dark}}}{0.980} \times 100\%$$

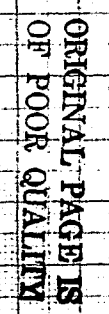
$$= 7.1\%$$

Requirement  
5% to 20%



3-12

|     |    |    |           |
|-----|----|----|-----------|
| 143 | 38 | 30 | Reference |
|-----|----|----|-----------|



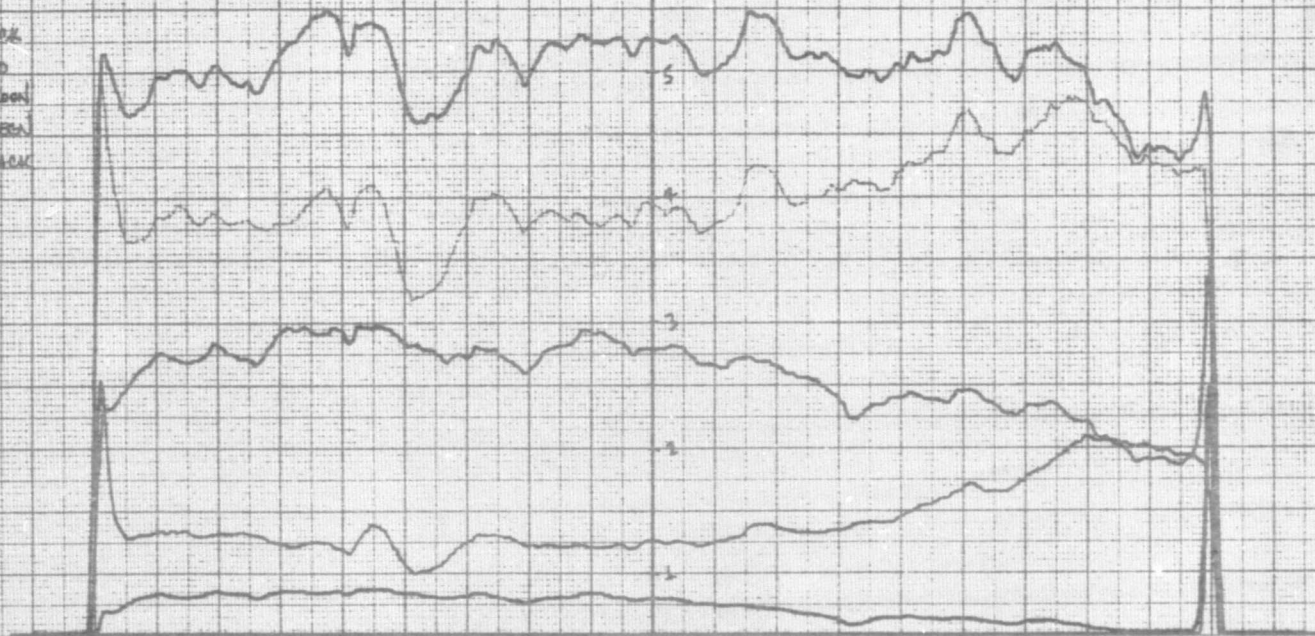
# SENSOR DATA BLOCK

3-13

|                                            |              |
|--------------------------------------------|--------------|
| BLOCK S/N: 0013                            | DATE: 8/7/76 |
| SENSOR: PAS AZIMUTH                        |              |
| DESC FINAL PERFORMANCE P4.15.7             |              |
| TEMP:                                      |              |
| SENSOR PEAK:                               |              |
| SOLAR PEAK:                                |              |
| SPACE PEAK:                                |              |
| SPACE GAIN: NULL:                          |              |
| X FULL SCALE: 10°/div Y FULL SCALE: 2V/div |              |

0° 1.86 mA BLACK  
 +85° 1.84 mA RED  
 +85° 1.84 mA MAGENTA  
 -45° 1.88 mA GREEN  
 -85° 1.88 mA BLUE

to 2000 only  
 XMA DCS



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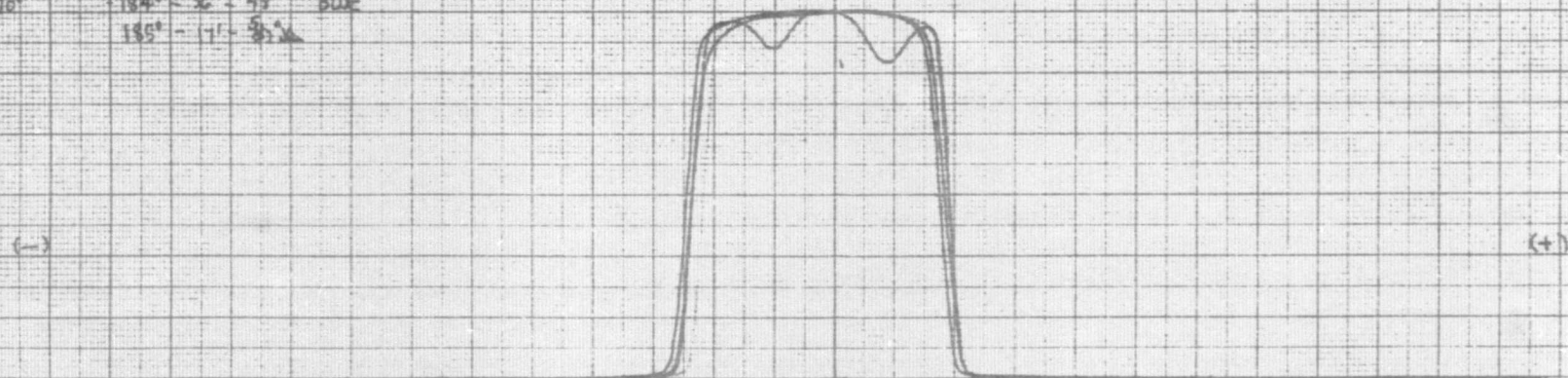
BR-147 8-69

10-5 10-10 10-15 INCH 47 1323  
 10-5 10-10 10-15 INCH 47 1323  
 10-5 10-10 10-15 INCH 47 1323



## 3-14

| Reference | 175°-00°-00°             |       |
|-----------|--------------------------|-------|
| 0°        | -24°-35'-02"             | BLACK |
|           | 275°-16'-07"             |       |
| 90°       | -04°-31'-48"             | RED   |
|           | 05°- <del>57'</del> 41"  |       |
| 180°      | -94°-37'-49"             | GREEN |
|           | 95°-18'-50"              |       |
| 270°      | -184°-36'-43"            | BLUE  |
|           | 185°-11'- <del>53"</del> |       |



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TO K 15 145 1/4 INCH 47 1323  
IN 1/4 INCH  
K 15 145 1/4 INCH 47 1323

# SENSOR DATA BLOCK

3-15

|                                                |              |
|------------------------------------------------|--------------|
| BLOCK S/N: 003                                 | DATE: 3/6/76 |
| SENSOR: PAS                                    | P 4.16.9     |
| DESC FINAL PERFORMANCE                         |              |
| ELEVATION                                      | TEMP         |
| SENSOR PEAK:                                   |              |
| SOLAR PEAK:                                    |              |
| SPACE PEAK:                                    |              |
| SPACE GAIN:                                    | MULT:        |
| X FULL SCALE: 10' (100) Y FULL SCALE: 1' (100) |              |

60.4 wss daily  
New DCS

TRIP-ON 9.075 V.  
TRIP-OFF 9.071 V.  
DARK 9.001 V.

Reference 2°-05'-30"

0° - 2°-05'-30" BLACK  
2°-46'-30"  
90° - 0°-00'-00" RED  
2°-45'-30"  
180° - 0°-05'-00" GREEN  
0°-45'-00"  
270° - 2°-04'-00" BLUE  
2°-46'-30"

0°-0' Reference

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(-)

(+)



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DOC NO 49959

DATE

CODE IDENT NO 13993

SHEET 68 REV A

SN003 RETEST  
FINAL 10/1/76

## Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt<br>Angle<br>(degrees) | Peak<br>Amplitude<br>(volts) | (1)<br>-Az Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Az Angle<br>at 1/2 PK Amp<br>(degrees) |
|----------------------------|------------------------------|------------------------------------------------|------------------------------------------------|
|                            |                              |                                                |                                                |
| +1.00                      |                              |                                                |                                                |
| 0.75                       |                              |                                                |                                                |
| 0.50                       | 0.82                         |                                                |                                                |
| 0.25                       | 2.30                         | -90°                                           | +90°                                           |
| 0.0                        | 3.90                         | -90°                                           | +90°                                           |
| -0.25                      | 2.97                         | -89°                                           | +90°                                           |
| -0.50                      | 0.72                         |                                                |                                                |
| -0.75                      |                              |                                                |                                                |
| -1.00                      |                              |                                                |                                                |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

✓ Check





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DATE

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SHEET

69

REV

A

SN003  
FINAL RE-TEST  
10/7/76

### Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table.

| Azimuth<br>Angle<br>(degrees) | Space Corrected (1)          |                                           | (2)                                       |                     |
|-------------------------------|------------------------------|-------------------------------------------|-------------------------------------------|---------------------|
|                               | Peak<br>Amplitude<br>(volts) | -Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | +Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | F.O.V.<br>(degrees) |
| -85                           | 4.99                         | $\epsilon^- = -0.393$                     | $\epsilon^+ = 0.267$                      | 0.650               |
| -45                           | 6.46                         | $-0.350$                                  | 0.293                                     | 0.663               |
| 0                             | 6.12                         | $\xi^- = -0.317$                          | $\xi^+ = 0.300$                           | 0.617               |
| +45                           | 4.89                         | $-0.350$                                  | 0.300                                     | 0.650               |
| 85                            | 4.42                         | $\eta^- = -0.383$                         | $\eta^+ = 0.293$                          | 0.667               |

The sun sensor field of view (|column 1 - column 2|) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

Check

SEE MDR #A30291

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\xi^- + \xi^+)}{2}$$

$$= -0.009^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(\epsilon_+ - \epsilon_- + \eta_- + \eta_+)}{4}$$

$$= 0.004^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge Trip Point Offset

$$0.300^\circ$$

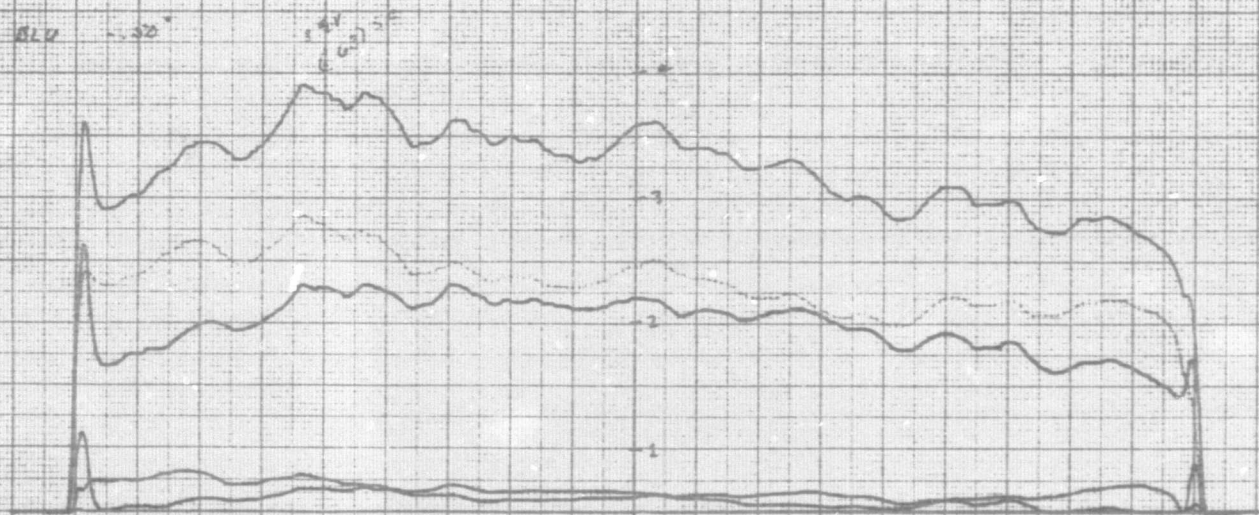
Reference Only

# SENSOR DATA BLOCK

3-1

BLOCK S/N: 003 DATE: 10-8-76  
 SENSOR: PMS  
 DESC: FINAL TEST P-2  
 MDC A 30291 TEMP:  
 SENSOR PEAK:  
 SOLAR PEAK:  
 SPACE PEAK:  
 SPACE GAIN: NULL:  
 X FULL SCALE: 10%/V FULL SCALE: 1V/2IN

STD 2.07 BLK 0°  
 2.08 Red +2.5°  
 2.08 MAGN +.50°  
 2.08 GAN -2.5°  
 2.08 BLU -2.0°



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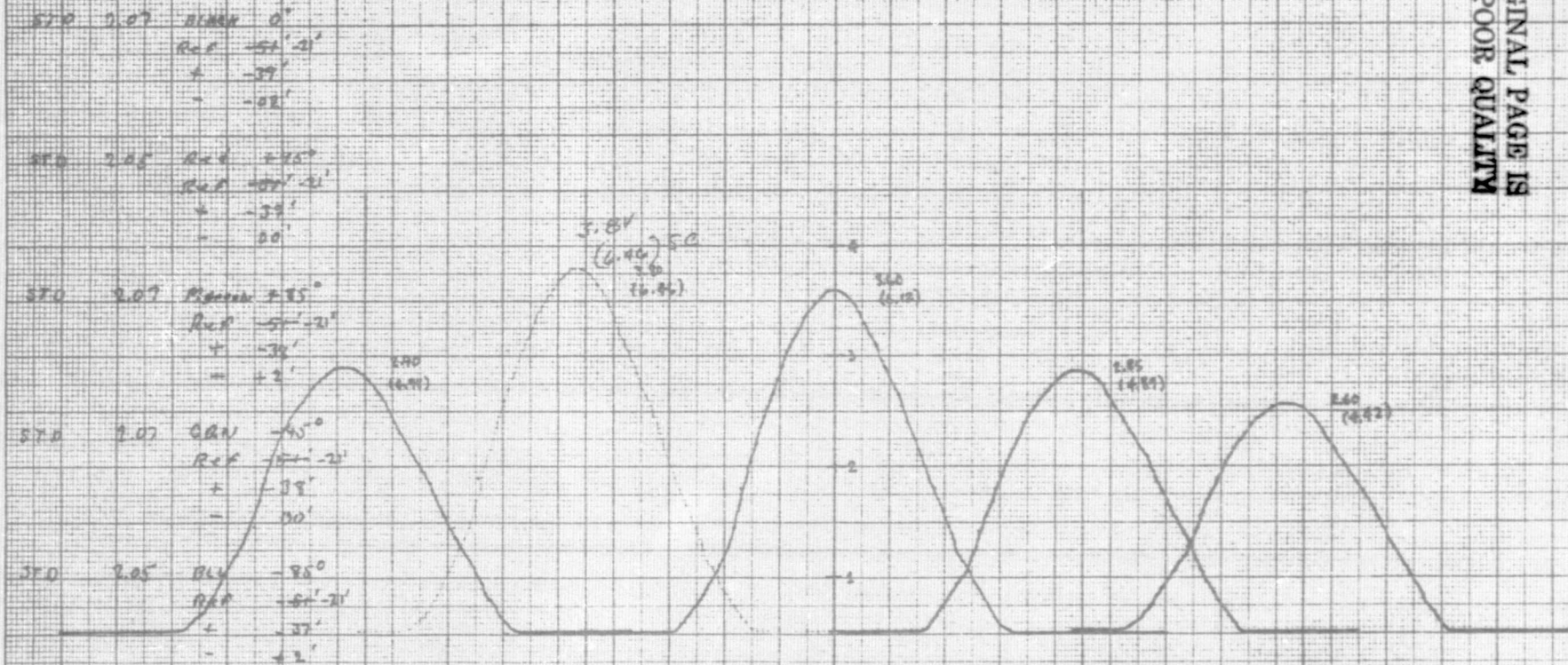


# SENSOR DATA BLOCK

3-2

BLOCK S/N: 063 DATE: 10-9-76  
 SENSOR: PAS  
 DESC: FINAL  
 RLY MDR A 50-91 TEMP:  
 SENSOR PEAK:  
 SOLAR PEAK:  
 SPACE PEAK:  
 SPACE GAIN: NULL  
 X FULL SCALE: 10/100 Y FULL SCALE: 10/10

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BR-147 B

10 X 10 TO 1/2 INCH 47 1323  
10 X 10 TO 1/2 INCH 47 1323  
10 X 10 TO 1/2 INCH 47 1323





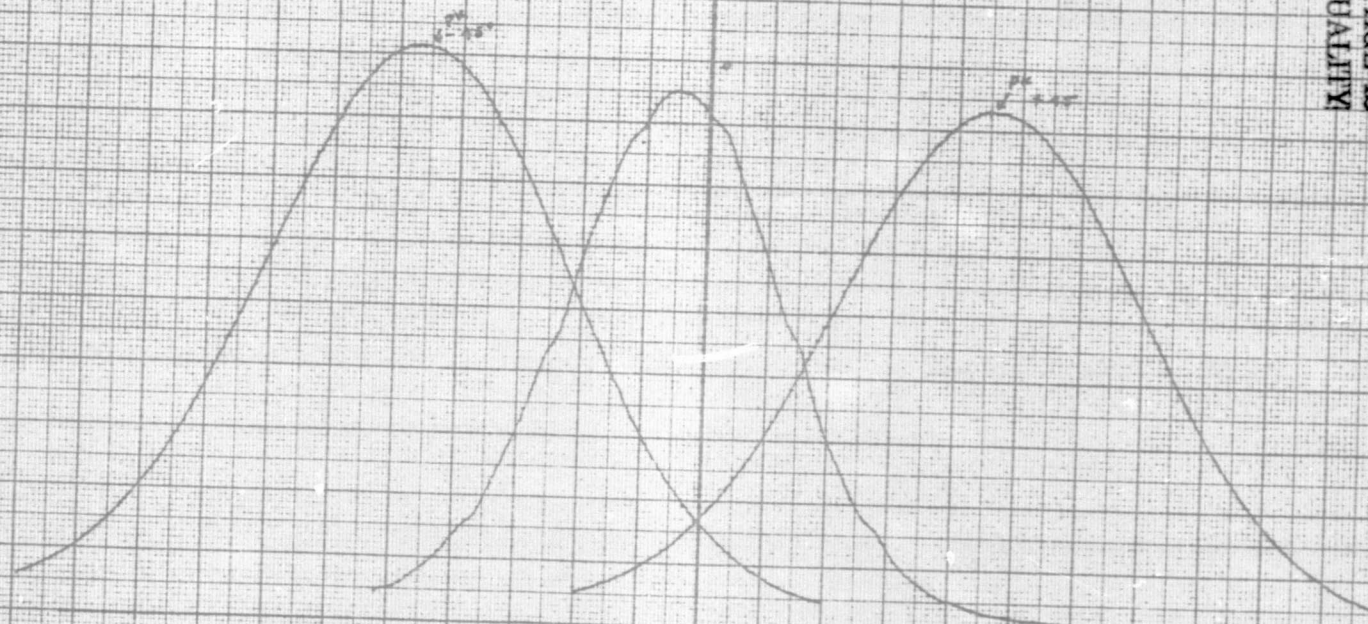
# SENSOR DATA BLOCK

3-4

|                                                       |               |
|-------------------------------------------------------|---------------|
| BLOCK #/N: 003                                        | DATE: 9/16/70 |
| SENSOR: <i>LA</i>                                     |               |
| DESC: <i>Refined Air M38. A80291 P3</i>               |               |
| 50K (0.000)                                           | TEMP          |
| SENSOR PEAK:                                          |               |
| SOLAR PEAK:                                           |               |
| SPACE PEAK:                                           |               |
| SPACE GAIN:                                           | NULL:         |
| X FULL SCALE: <i>1.000</i> Y FULL SCALE: <i>5.000</i> |               |

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*Blue* - 0° = 7.76V = 77.6%  
 - 45° = 7.76V = 77.6%  
 - 90° = 7.76V = 77.6%



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 BOULDER COLORADO

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# SENSOR DATA BLOCK

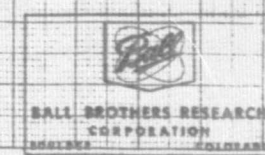
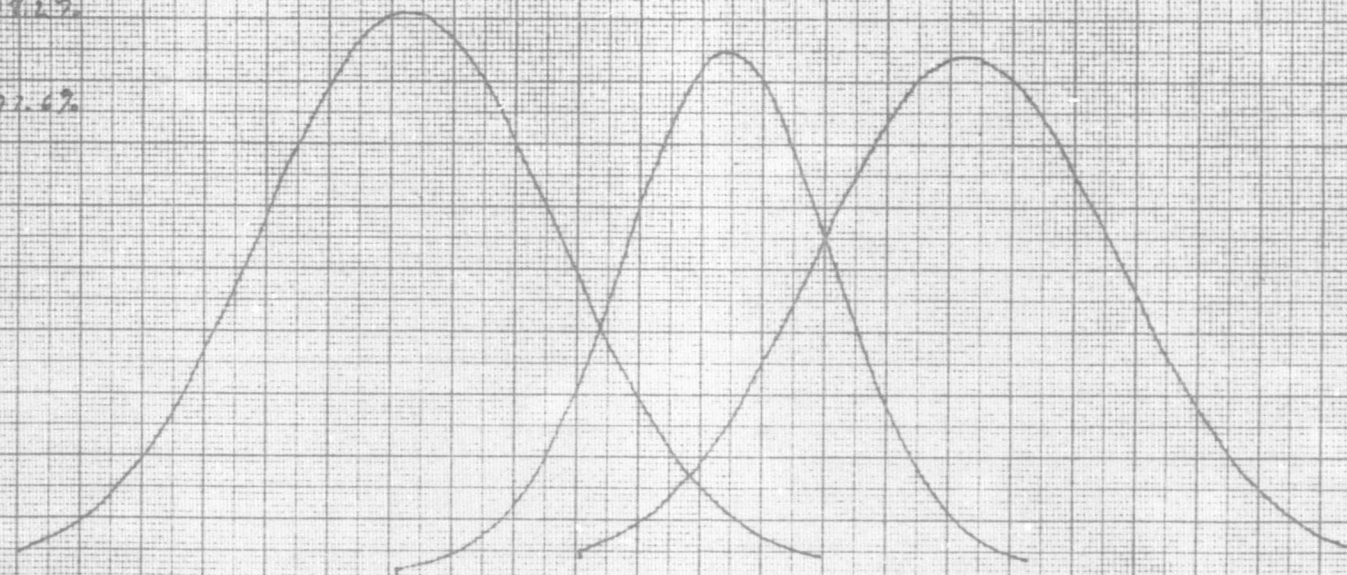
3-5

|                                      |               |          |
|--------------------------------------|---------------|----------|
| BLOCK S/N: 003 55                    | DATE: 9-21-70 | 50K Load |
| SENSOR: PPS                          |               |          |
| DESG: POST-ULD                       |               |          |
| TEMP:                                |               |          |
| SENSOR PEAK:                         |               |          |
| SOLAR PEAK:                          |               |          |
| SPACE PEAK:                          |               |          |
| SPACE GAIN: NULL:                    |               |          |
| X FULL SCALE: 0.25 Y FULL SCALE: 0.1 |               |          |

0° 77.2% Peak II .450  $\mu$  77.6%  
 SPACE PEAK .580

-45° 78.2%

+45° 77.6%



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BR 147 8-69

10 X 10 TO 10 1/2 INCH 47 1323  
 MADE IN U.S.A.  
 K&E  
 KATHLEEN E. KENNEDY CO.

|      |     |     | inner   | outer | $\Delta$ |       |
|------|-----|-----|---------|-------|----------|-------|
| 8.25 | rot | (6) | 6 in-lb | .4818 | .5761    | .0943 |
|      |     |     |         | .6971 | .7885    | .0914 |
| 9.75 | rot | (7) | 8 in-lb | 3.426 | 4.511    | 1.085 |
| 8.55 | rot | (8) | 6 in-lb | .6878 | .7769    | .089  |

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|     | Tag     | set width          | Peak out. | Rel. Sum | Adj. peak |
|-----|---------|--------------------|-----------|----------|-----------|
| (1) | 6 in-lb | .085 - .0057 (1.5) | 8.85      | .800*    | 8.85      |
| (2) | 3       | .080               | 7.69      |          |           |
| (3) | 10      | .088 (inner)       | 10.70     |          |           |
| (4) | 6       | .081 (2)           | 8.80      | .808     | 8.31      |
| (5) | 4.5     | .076 (2)           | 8.22      | .805     | 8.16      |
| (6) | 6       | .093 (2)           | 8.75      | .804     | 8.71      |
| (7) | 3       | .104 (1)           | 9.75      | .807     | 9.82      |
| (8) | 6       | .089               | 8.85      | .809     | 8.76      |

mean 8.75

$$92.44 \times 7.617$$

Torque (in-lb)



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# 2 + 3 Torque tests.

Shows a consistent pattern of increasing sensitivity  
with torque. 6 in.-lb is taken for + last First is  
always more sensitive than last.

4/21 Call to GSC

#6 has roll pin instead of solid pin

\* MDR A-30291 W003

~~PT 10136~~  
One of the #2 screws protruded through  
back of slit assembly. 1



For install washer under screw heads

(W005 has had the screws shortened (apparently  
they do not protrude!!)

Slit in M4 - (Repeatability check)

|             |  | inner | outer | mm    | $\Delta$               |
|-------------|--|-------|-------|-------|------------------------|
| ① 6 in.-lb  |  | 6016  | 60892 |       | 0.876                  |
|             |  | 7478  | 8364  |       | 0.886                  |
|             |  | 9598  | 10347 |       | 0.749                  |
|             |  | 9038  | 9917  |       | 0.879                  |
|             |  | 7190  | 8028  |       | 0.838                  |
| ② 3 in.-lb  |  | 5279  | 6082  | mm    | 0.8456                 |
|             |  |       | 60803 |       | 0.0571                 |
| ③ 10 in.-lb |  | 3526  | 4367  | #     |                        |
|             |  |       | 1.084 |       | 106697 + 10024 w/o (4) |
| ④           |  | 2752  | 3660  | 1.091 |                        |
| ⑤           |  | 2278  | 3037  | 1.076 |                        |
| ⑥           |  | 1913  | 2765  | 1.085 |                        |
| ⑦           |  |       |       |       |                        |

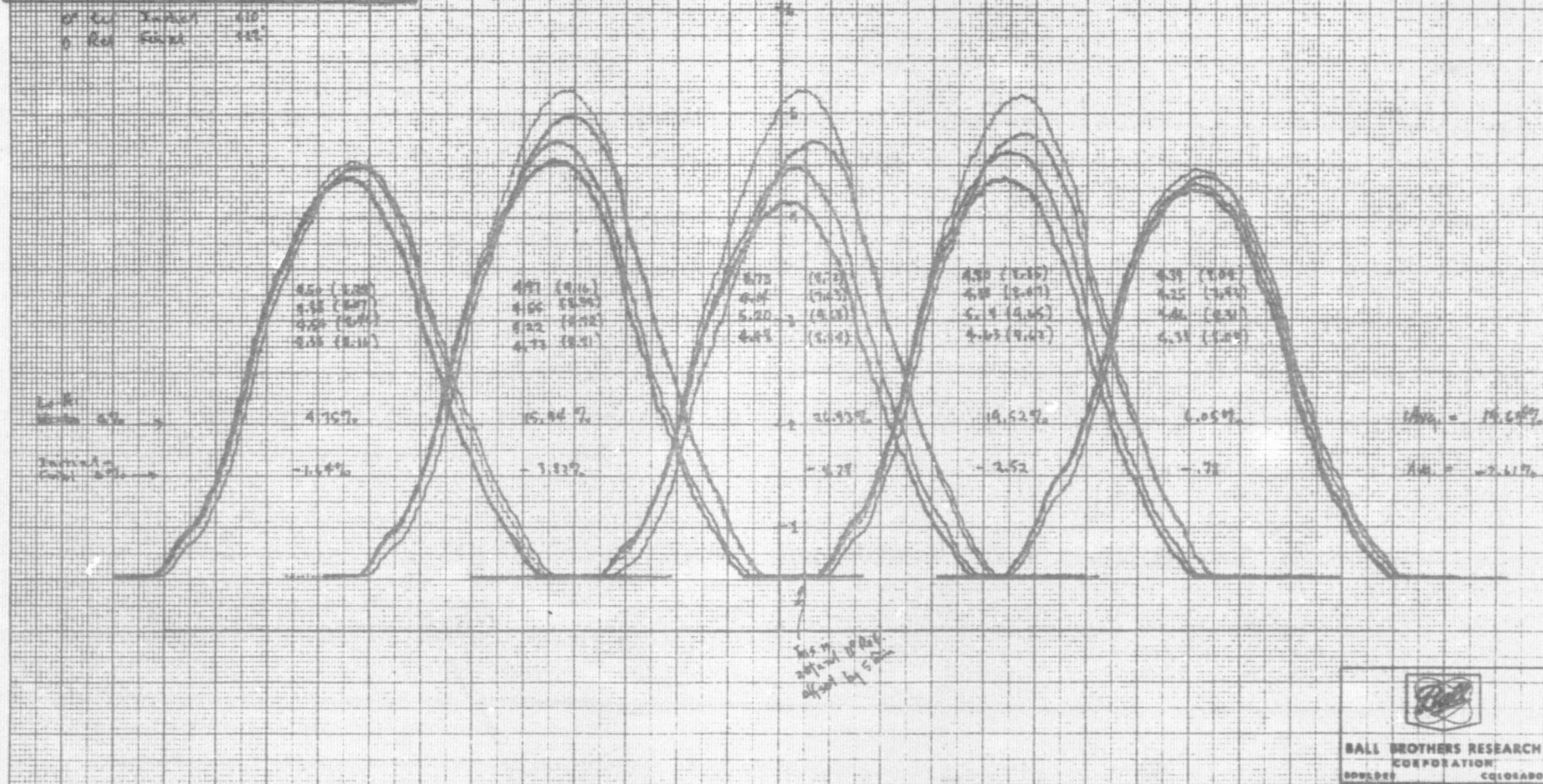
### SENSOR DATA BLOCK

3-4

|                        |                      |
|------------------------|----------------------|
| BLOCK #/N = 005        | DATE = 9/16          |
| SENSOR: PFS            | 2.1                  |
| DESC: REEST PER MDR    | A 50194<br>A 54221   |
| A 5 SUN DIT ATTACHMENT | SCOW TEMP            |
| SENSOR PEAK:           |                      |
| SOLAR PEAK:            |                      |
| SPACE PEAK:            |                      |
| SPACE GAIN:            | NULL                 |
| X FULL SCALE = 30 /m   | Y FULL SCALE = 30 /m |

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|       |         |       |
|-------|---------|-------|
| Blue  | 1.91 mA | 6" #  |
| Red   | 1.91 mA | 3" #  |
| Green | 1.89 mA | 10" # |
| Pink  | 1.89 mA | 6" #  |



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# SENSOR DATA BLOCK

3-7

|                                 |                      |
|---------------------------------|----------------------|
| BLOCK 5/M: 002                  | DATE: 7-16-76        |
| SENSOR: SS R&Tcat Part 2 of VMC |                      |
| DESC:                           |                      |
| TEMP:                           |                      |
| SENSOR PEAK:                    |                      |
| SOLAR PEAK:                     |                      |
| SPACE PEAK:                     |                      |
| SPACE GAIN:                     | NULL:                |
| X FULL SCALE: 100/100           | Y FULL SCALE: 10/100 |

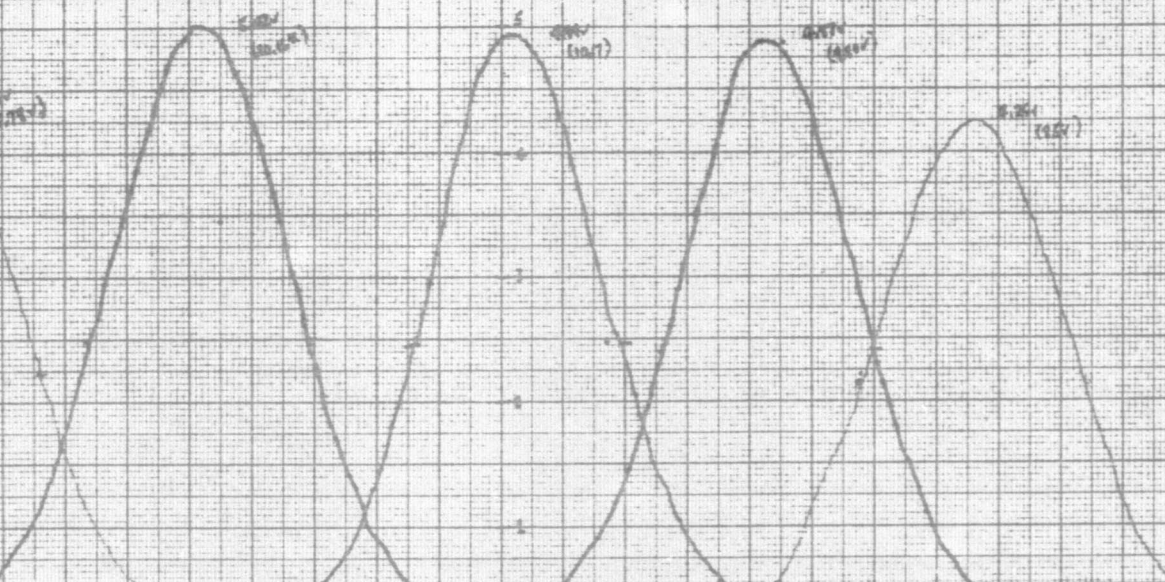
OLA 1° STD 171.00  
 Peak -11° 00"  
 -31° 00"  
 +24° 30"

Red +45° STD 175.00  
 Peak -25° 30" (0.75)  
 +13° 30"

GRN +55° STD 176.00  
 Peak -21° 00"  
 +36° 00"

Red -45° STD 174.00  
 Peak -23° 00"  
 +13° 00"

GRN -55° STD 175.00  
 Peak -20° 00"  
 +16° 00"



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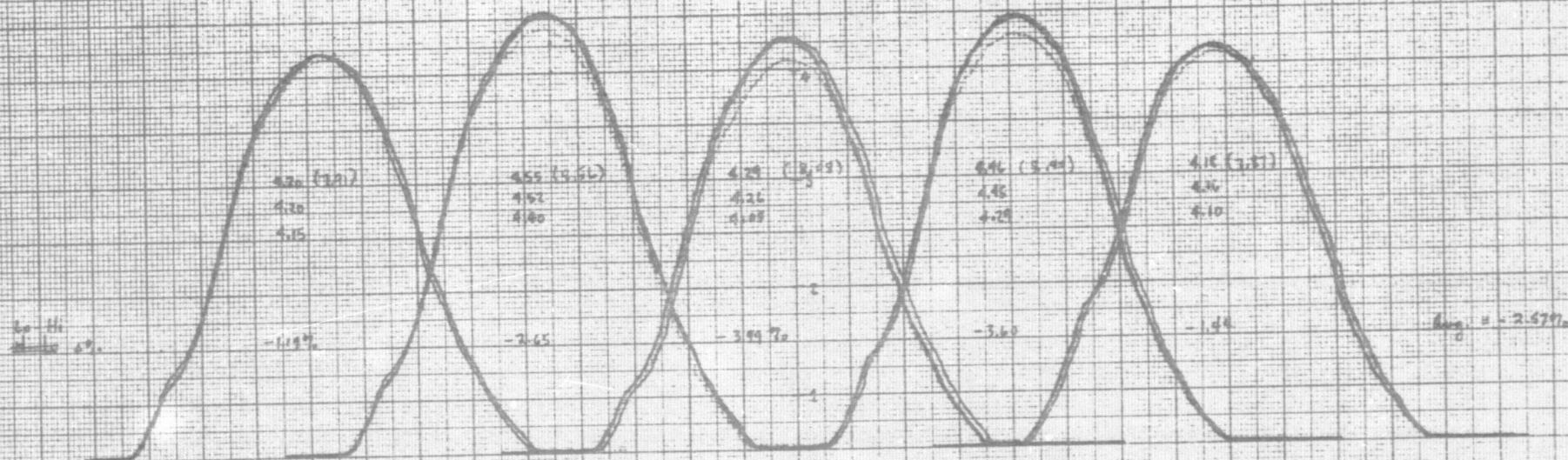
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NO. 10 X 10 TO 1/2 INCH 47 1323  
 1/2 INCH 1/2 INCH 1/2 INCH  
 KODAK SAFETY FILM



## 3-E

|     |        |       |
|-----|--------|-------|
| OLK | 187 mA | 6" #  |
| Pnd | 196 mA | 3" #  |
| GBN | 186 mA | 18" # |



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# SENSOR DATA BLOCK

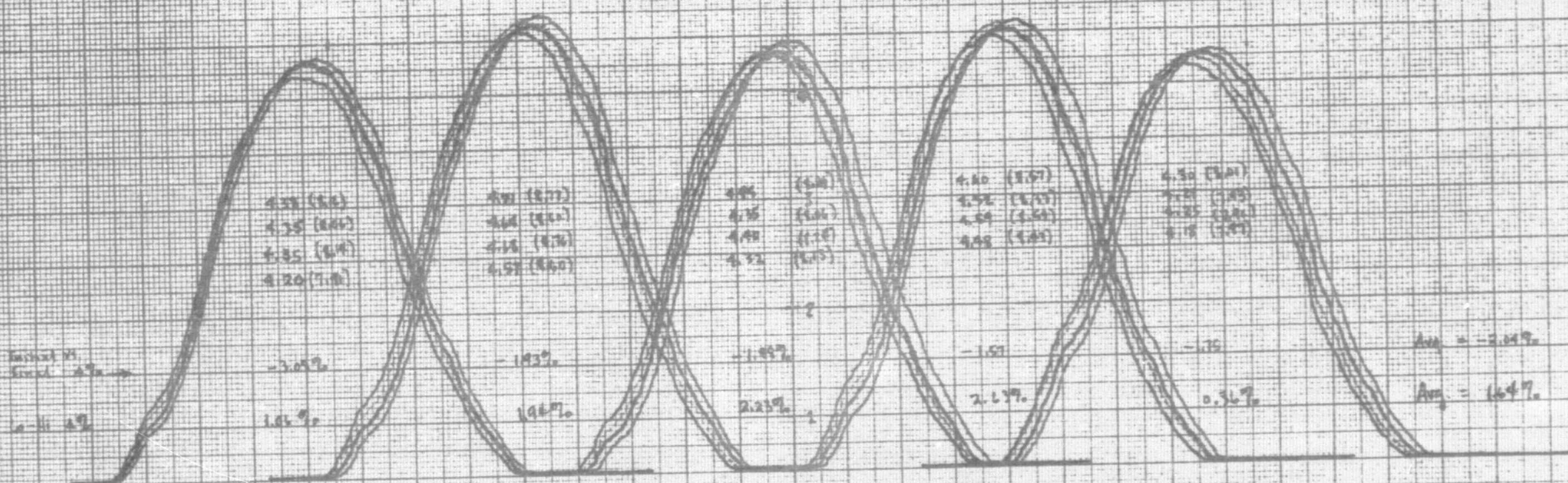
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3-9

|                                                  |       |              |
|--------------------------------------------------|-------|--------------|
| BLOCK S.N. 002                                   | PHS   | DATE: 7-7-76 |
| SENSOR: <i>MS-200</i>                            |       |              |
| DESC: <i>Retest PCB MDR</i>                      |       |              |
| MS-200 S/N: 000005                               | TEMP: |              |
| SENSOR PEAK:                                     |       |              |
| SOLAR PEAK:                                      |       |              |
| SPACE PEAK:                                      |       |              |
| SPACE GAIN: <i>NO. 1</i>                         |       |              |
| X FULL SCALE: <i>0.1</i> Y FULL SCALE: <i>10</i> |       |              |

OLN 1.88 mA 2.5" #  
Rad 1.90 mA 1" #  
GRN 1.88 mA 4" #  
OLN 1.87 mA 2.5" #

Ref 0° 10' 0"  
Ref 15'



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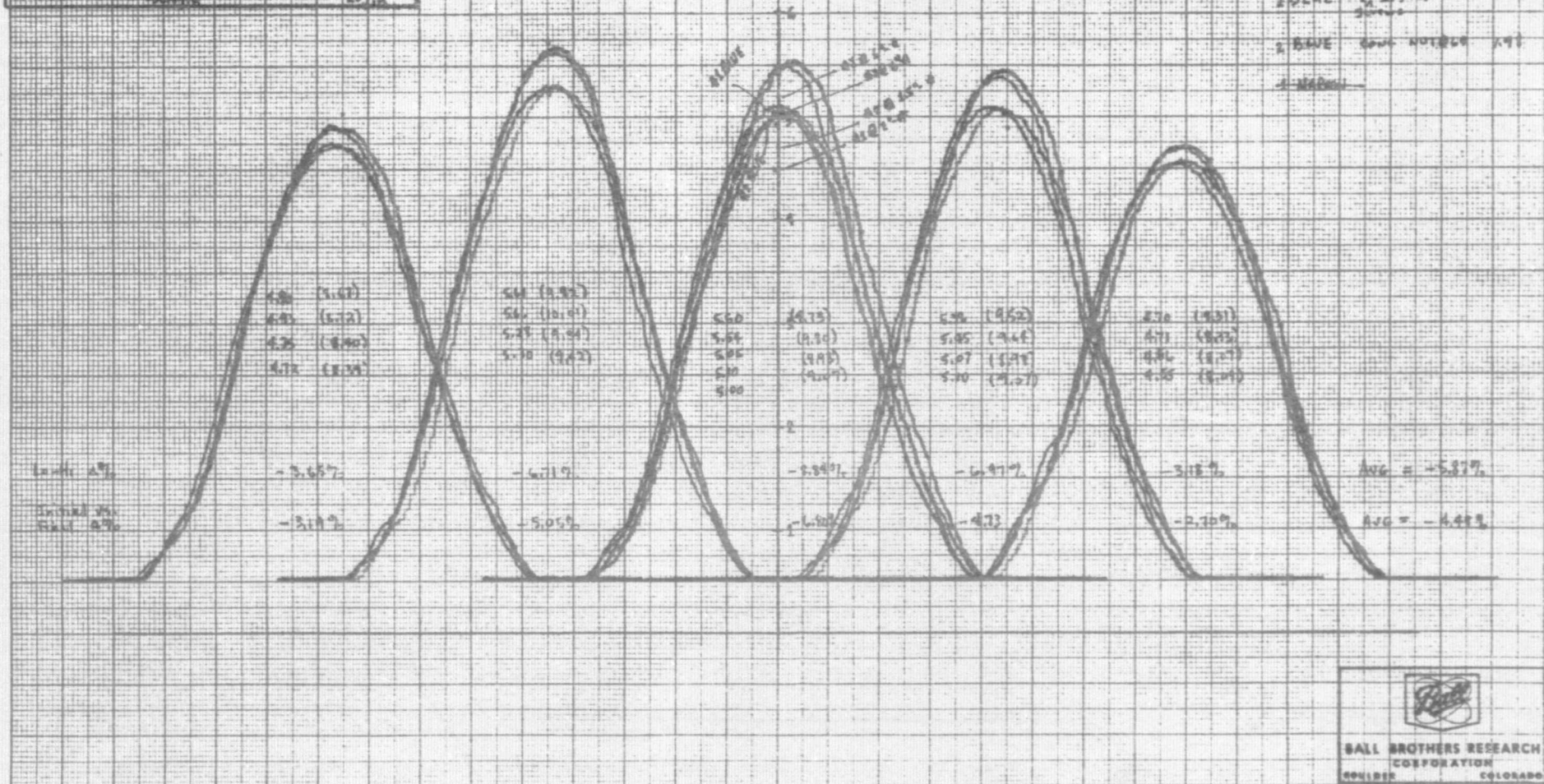


# SENSOR DATA BLOCK

3-10

|                                     |                      |
|-------------------------------------|----------------------|
| BLOCK S/N: 003                      | DATE: 4/2/76         |
| SENSOR: PAS                         |                      |
| DESC: RETEST PER MDR 130194         |                      |
| TROVE TO NOMINAL FROM TEMP: INITIAL |                      |
| SENSOR PEAK:                        |                      |
| SOLAR PEAK:                         |                      |
| SPACE PEAK:                         |                      |
| SPACE GAIN: NULL                    |                      |
| X FULL SCALE: 2.5 in                | Y FULL SCALE: 2.5 in |

BLACK INITIAL 1.99mA  
 RED ACTIVE TROVE 1.99mA  
 GREEN TROVE TO NOMINAL (L) 1.99mA  
 44-4444 only  
 BLUE #2 2.5 in 1.95mA  
 3 BLUE 44-4444 1.95mA  
 4-4444



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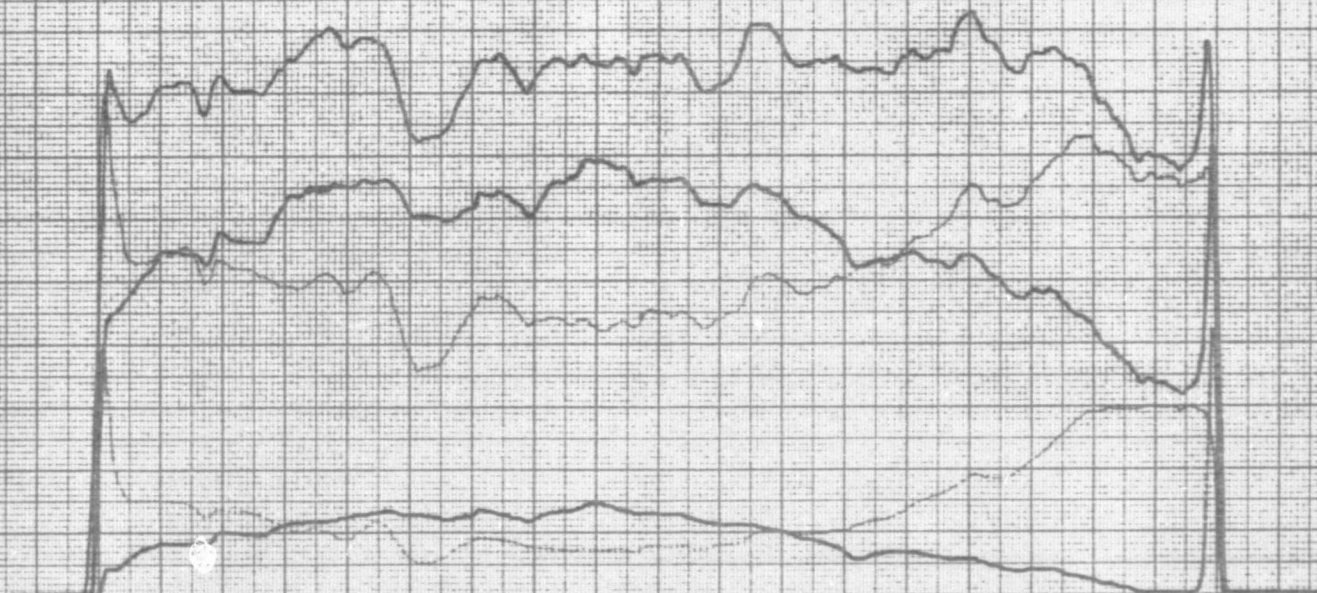
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3-11

|                |                    |                |                    |
|----------------|--------------------|----------------|--------------------|
| BLOCK S/W =    | 65                 | DATE =         | 7-16-78            |
| SENSOR =       | SOLAR TEST PLOT 1  | 152            | 14C                |
| DESC           |                    |                |                    |
|                |                    | TEMP           |                    |
| SENSOR PEAK:   |                    |                |                    |
| SOLAR PEAK:    |                    |                |                    |
| SPACE PEAK:    |                    |                |                    |
| SPACE GAIN:    |                    | NULL           |                    |
| X FULL SCALE = | 10 <sup>10</sup> W | Y FULL SCALE = | 10 <sup>10</sup> W |

|             |      |      |
|-------------|------|------|
| $0^\circ$   | 89.0 | 1.76 |
| $+10^\circ$ |      | 1.75 |
| $+20^\circ$ |      | 1.75 |
| $-15^\circ$ |      | 1.82 |
| $-30^\circ$ |      | 1.81 |



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图 8-147 8-6

**K $\times$  $\Sigma$**  10 X 10 TO 1/4 INCH 47 1323  
1- 1/8 INCHES PART IN U.S.A.  
RUFFEL & ESSER CO.





**Ball Brothers Research Corporation**

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BOULDER COLORADO 80302

DOC NO 49959

DATE

CODE IDENT NO 13993

SHEET 54 REV

# Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Performance-Panoramic Attitude Sensor, 49959.

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## 3.2 SERIAL NUMBER

- Scanner head serial number 004
- Main Electronics serial number 004

## 3.3 TEST OPERATOR

- Signature of test operator R.C. Dwyer
- Date of start of test 8-5-76
- Date of end of test 8-5-76

## 3.4 EQUIPMENT REQUIRED

- Visicorder, Honeywell 1508, S/N <sup>5362 Jan 9/76</sup> ~~86401~~, Cal. Due N/A
- High Voltage Power Supply, Fluke 301C or equivalent  
— S/N B9809
- Oscilloscope with camera, Tektronix ~~547~~ or equivalent  
7633 S/N C-9002, Cal. date 1/17/76
- Current probe, Tektronix P6042 or equivalent —,  
S/N BARC 8221, Cal. date 1/3/77
- DVM, H-P ~~3440~~ or equivalent 3465A, S/N C-9247,  
Cal. date 1/1/77
- Current Meter, Weston 911 or equivalent —,  
S/N NAS-464, Cal. date 1-2-77
- VOM, Simpson 270 or equivalent HP 3465A DMM  
S/N C9255, Cal. date 1-1-77
- Precision power supply, H-P 6114A or equivalent —,  
S/N C5795, Cal. date 1-22-77
- Pulse generator, Tektronix ~~2102~~ or equivalent 2101,  
S/N BARC-8226, Cal. date 11/5/76
- X-Y Plotter, H-P 7047A or equivalent —,  
S/N C9047, Cal. date 11-19-77
- Dividing Head, 2 axis, Leitz Imperial Series 72 or  
equivalent B126H, S/N B126H, Cal. date 1-12-77







## Data Sheet 2

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3.6.1 Self Check

Check ☒

3.6.2 Test Set Supply Voltages

| FUNCTION | MEASUREMENT   | REQUIREMENT    |
|----------|---------------|----------------|
| +28v     | <u>.68</u> mA | 0.7 $\pm$ 0.07 |
| +12v     | <u>.61</u> mA | 0.6 $\pm$ 0.06 |
| +10v     | <u>.48</u> mA | 0.5 $\pm$ 0.05 |
| + 8v     | <u>.83</u> mA | 0.8 $\pm$ 0.08 |
| + 5v     | <u>.50</u> mA | 0.5 $\pm$ 0.05 |
| - 5v     | <u>.52</u> mA | 0.5 $\pm$ 0.05 |

4.1.1 Ground Continuity

| Measure from<br>Pin to Pin    | Function     | Measurement    | Requirement |
|-------------------------------|--------------|----------------|-------------|
| 20 Electronics box<br>chassis | CHASSIS GND. | <u>.10</u> Ohm | <0.2 Ohms   |
| 20 21                         | CHASSIS GND. | <u>.06</u> Ohm | <0.2 Ohms   |
| 17 19                         | 28v Ret.     | <u>.17</u> Ohm | <0.2 Ohms   |
| 12 13                         | SIG. GND.    | <u>.17</u> Ohm | <0.2 Ohms   |

4.1.2 Ground Isolation

| Measure from<br>Pin to Pin | Function  | Measurement         | Requirement     |
|----------------------------|-----------|---------------------|-----------------|
| 20 12                      | SIG. GND. | <u>&gt;10 M</u> Ohm | >100 k $\Omega$ |
| 20 17                      | 28v Ret.  | <u>&gt;10 M</u> Ohm | >100 k $\Omega$ |

4.2.1 Thermistor Continuity

| Measure from<br>Pin to Pin | Function                     | Measurement             | Requirement        |
|----------------------------|------------------------------|-------------------------|--------------------|
| 14 15                      | Elect. Thms. 1 ( $R_{et1}$ ) | <u>11.12</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 33 34                      | Elect. Thms. 2 ( $R_{et2}$ ) | <u>11.09</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 35 36                      | Scan. Thms. 1 ( $R_{st1}$ )  | <u>10.75</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 37 5                       | Scan. Thms. 2 ( $R_{st2}$ )  | <u>10.79</u> k $\Omega$ | 5k to 15k $\Omega$ |





## Data Sheet 3

## 4.2.2 Electronics Thermistor Resistance

$$\Delta R = \frac{(R_{et1} - R_{et2}) \times 100\%}{R_{et1}} = \frac{(\underline{11.12} \text{ k}\Omega - \underline{11.07} \text{ k}\Omega) \times 100\%}{\underline{11.12} \text{ k}\Omega}$$

$$R_{et1} = \underline{.27} \%$$

Requirement:  $\pm 4\%$ 

## 4.2.3 Scanner Thermistor Resistance

$$\Delta R = \frac{(R_{st1} - R_{st2}) \times 100\%}{R_{st1}} = \frac{(\underline{10.75} \text{ k}\Omega - \underline{10.74} \text{ k}\Omega) \times 100\%}{\underline{10.75} \text{ k}\Omega}$$

$$R_{st1} = \underline{.37} \%$$

Requirement:  $\pm 4\%$ 

## 4.2.4 Thermistor Isolation

Measure from  
Pin to Pin

Function

Measurement

Requirement

|    |    |                |                             |                 |
|----|----|----------------|-----------------------------|-----------------|
| 14 | 20 | Elect. Thms. 1 | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 34 | 20 | Elect. Thms. 2 | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 35 | 20 | Scan. Thms. 1  | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |
| 37 | 20 | Scan. Thms. 2  | <u>&gt; 10 M</u> k $\Omega$ | > 100k $\Omega$ |

## 4.3.3 Initial Turn On

Check ☒

## 4.4.3 Idle Input Current

Function

Measurement

Requirement

28v input current  
( $I_{in}$ )49 mA50mA  $\pm$  25mA28v input voltage  
( $V_{in}$ )28.06 V28V  $\pm$  0.28V

## 4.4.4 Idle Input Power

$$P_i = E_{in} \times I_{in}$$

$$= \underline{28.06} \text{ V} \times \underline{49} \text{ mA}$$

$$= \underline{1375} \text{ mW. Reference reading only.}$$





## Data Sheet 4

4.4.6 Scanner Rotation

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4.4.7 Running Power

FunctionMeasurement28v input current  
( $I_{in}$ )165 mA

Reference only

28v input voltage  
( $E_{in}$ )28.02 V

Reference only

$$P_r = E_{in} \times I_{in}$$

$$= 28.02V \times 165 \text{ mA}$$

$$= 4623 \text{ mW}$$

Requirement &lt;5.0 watts

4.4.11 Main Electronics Power

FunctionMeasurement28v input current  
( $I_{in}$ )33 mA

Reference only

28v input voltage  
( $E_{in}$ )28.08 V

Reference only

$$P_c = E_{in} \times I_{in}$$

$$= 28.08V \times 33 \text{ mA}$$

$$P_c = 927 \text{ mW}$$

Requirement &lt;1.0 watts

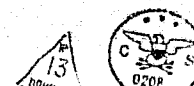
4.5 Power On Initialize

4.5.3 ☒ Check4.5.5 ☒ Check

$$4.5.7 \quad \text{OFFSET} = \frac{\text{AOS1} + \text{LOS1} + \text{AOS2} + \text{LOS2} + \text{AOS3} + \text{LOS3} - 1060}{6}$$

$$\text{OFFSET} = 1.33$$

Requirement: + 3

4.5.8 ☒ Check4.5.9 ☒ Check



## Data Sheet 5

## 4.6.1 Analog Telem Calibration

| Measure from<br>Pin to Pin |    | Function     | Measurement    | Requirement |
|----------------------------|----|--------------|----------------|-------------|
| 12                         | 9  | + 5v MONITOR | <u>4.184</u> V | 4.0 + 1.0V  |
| 12                         | 10 | +20v MONITOR | <u>4.104</u> V | 4.0 + 1.0V  |

## 4.7.2 Scanner Revolution Rate

| Rate (R) | Rate Readout | Measured Time   | Nominal Time |
|----------|--------------|-----------------|--------------|
| 0        | <u>0</u>     | <u>52</u> sec.  | 52 sec.      |
| 1        | <u>1</u>     | <u>26</u> sec.  | 26 sec.      |
| 2        | <u>2</u>     | <u>13</u> sec.  | 13 sec.      |
| 3        | <u>3</u>     | <u>6.5</u> sec. | 6.5 sec.     |

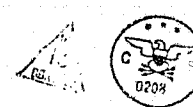
## 4.8 Invalid Data Test

4.8.1 ☒ Check4.8.2 ☒ Check

## 4.9 CW-CCW Test

4.9.2 ☒ Check4.9.4 ☒ Check4.9.5 ☒ Check4.9.6 ☒ Check4.9.7 ☒ Check

## 4.10 Sector Test

4.10.2 ☒ Check4.10.3 ☒ Check4.10.4 ☒ Check4.10.5 ☒ Check4.10.6 ☒ Check4.10.7 ☒ Check4.10.8 ☒ Check4.10.9 ☒ Check4.10.10 ☒ Check



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Data Sheet 6

|         |                                     |       |
|---------|-------------------------------------|-------|
| 4.10.11 | <input checked="" type="checkbox"/> | Check |
| 4.10.12 | <input checked="" type="checkbox"/> | Check |
| 4.10.13 | <input checked="" type="checkbox"/> | Check |
| 4.10.14 | <input checked="" type="checkbox"/> | Check |
| 4.10.15 | <input checked="" type="checkbox"/> | Check |
| 4.10.16 | <input checked="" type="checkbox"/> | Check |
| 4.10.17 | <input checked="" type="checkbox"/> | Check |
| 4.10.18 | <input checked="" type="checkbox"/> | Check |
| 4.10.19 | <input checked="" type="checkbox"/> | Check |
| 4.10.20 | <input checked="" type="checkbox"/> | Check |
| 4.10.21 | <input checked="" type="checkbox"/> | Check |
| 4.10.22 | <input checked="" type="checkbox"/> | Check |
| 4.10.23 | <input checked="" type="checkbox"/> | Check |
| 4.10.24 | <input checked="" type="checkbox"/> | Check |
| 4.10.25 | <input checked="" type="checkbox"/> | Check |
| 4.10.26 | <input checked="" type="checkbox"/> | Check |
| 4.10.27 | <input checked="" type="checkbox"/> | Check |
| 4.10.28 | <input checked="" type="checkbox"/> | Check |
| 4.10.29 | <input checked="" type="checkbox"/> | Check |
| 4.10.30 | <input checked="" type="checkbox"/> | Check |
| 4.10.31 | <input checked="" type="checkbox"/> | Check |
| 4.10.32 | <input checked="" type="checkbox"/> | Check |
| 4.10.33 | <input checked="" type="checkbox"/> | Check |
| 4.10.34 | <input checked="" type="checkbox"/> | Check |
| 4.10.35 | <input checked="" type="checkbox"/> | Check |
| 4.10.36 | <input checked="" type="checkbox"/> | Check |
| 4.10.37 | <input checked="" type="checkbox"/> | Check |







## Data Sheet 7

4.11.6 Sector Check

Check ✓

4.11.7 Power Supply Variation

POWER  
SUPPLYAOS/LOS  
DISPLAYΘ  
READOUT

26.60 + 0.26v (-4%)

✓✓

28.84 + 0.28v (+2%)

✓✓

28.00 + 0.28v (NOM)

✓✓

4.11.9 Clock Frequency Variations

Frequency at FailureRequirementUpper 20 MHz

&gt;12.9 MHz

Lower <5 MHz

&lt;10.0 MHz

4.12 Slow Data Rate

4.12.5 ✓ Check4.12.6 ✓ Check4.12.7 ✓ Check4.12.8 ✓ Check4.12.9 ✓ Check4.12.10 ✓ Check4.12.11 ✓ Check4.12.12 ✓ Check

4.13 Spherical Mode Check

4.13.4 ✓ Check4.13.5 ✓ Check4.13.6 ✓ Check4.13.7 ✓ Check4.13.8 ✓ Check4.13.9 ✓ Check4.13.10 ✓ Check



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Data Sheet 8

|         |                                           |
|---------|-------------------------------------------|
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| 4.13.12 | <input checked="" type="checkbox"/> Check |
| 4.13.13 | <input checked="" type="checkbox"/> Check |
| 4.13.14 | <input checked="" type="checkbox"/> Check |
| 4.13.15 | <input checked="" type="checkbox"/> Check |
| 4.13.16 | <input checked="" type="checkbox"/> Check |
| 4.13.17 | <input checked="" type="checkbox"/> Check |
| 4.13.18 | <input checked="" type="checkbox"/> Check |
| 4.13.19 | <input checked="" type="checkbox"/> Check |
| 4.13.20 | <input checked="" type="checkbox"/> Check |
| 4.13.21 | <input checked="" type="checkbox"/> Check |
| 4.13.22 | <input checked="" type="checkbox"/> Check |
| 4.13.23 | <input checked="" type="checkbox"/> Check |
| 4.13.24 | <input checked="" type="checkbox"/> Check |
| 4.13.25 | <input checked="" type="checkbox"/> Check |
| 4.13.26 | <input checked="" type="checkbox"/> Check |
| 4.13.27 | <input checked="" type="checkbox"/> Check |
| 4.13.28 | <input checked="" type="checkbox"/> Check |
| 4.13.29 | <input checked="" type="checkbox"/> Check |
| 4.13.30 | <input checked="" type="checkbox"/> Check |
| 4.13.31 | <input checked="" type="checkbox"/> Check |
| 4.13.32 | <input checked="" type="checkbox"/> Check |
| 4.13.33 | <input checked="" type="checkbox"/> Check |
| 4.13.34 | <input checked="" type="checkbox"/> Check |
| 4.13.35 | <input checked="" type="checkbox"/> Check |
| 4.13.36 | <input checked="" type="checkbox"/> Check |





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SHEET 62 REV

Data Sheet 9

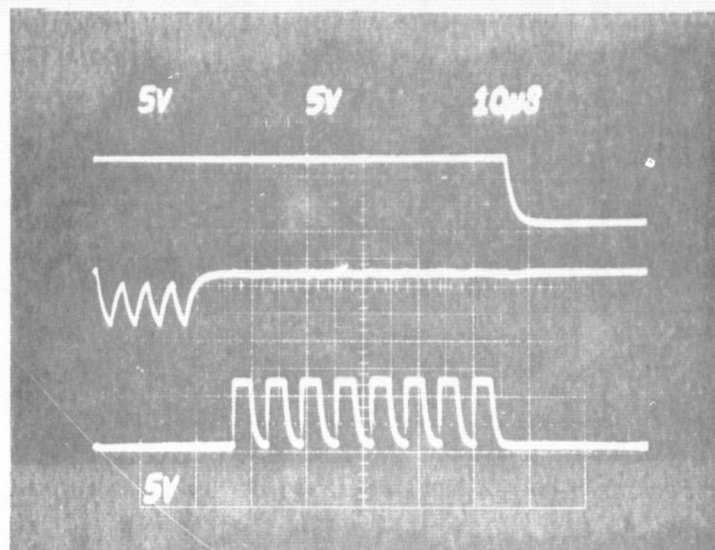
4.14.2

2v/cm

2v/cm

2v/cm

10 $\mu$ s/cm



DWG

Burst  
Clock

Shift  
Pulses

1.11.6

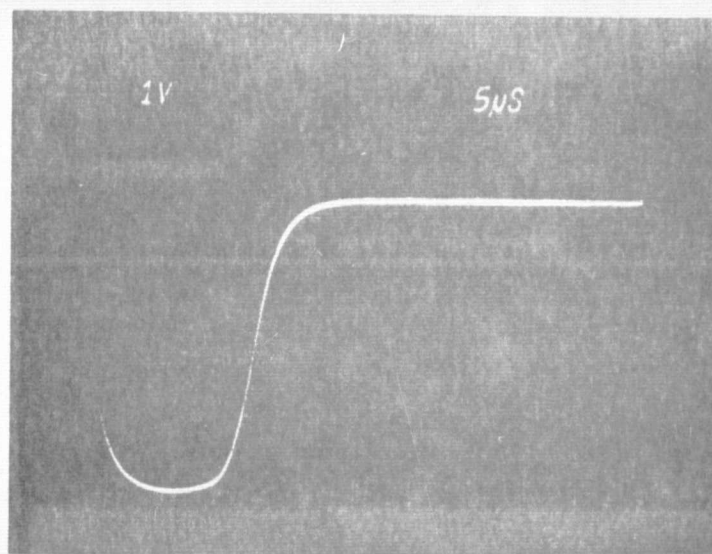
8/5/76

See MDR

#A 30199

1v/cm

5 $\mu$ s/cm



Load  
Pulse

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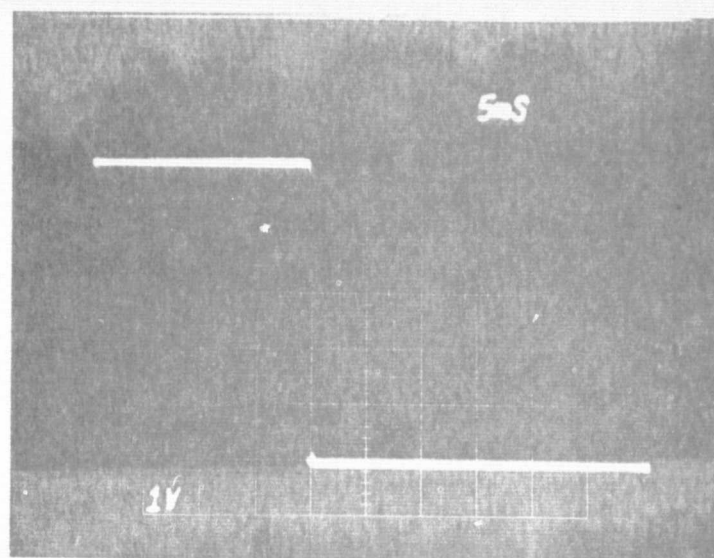
SHEET 03 REV

Data Sheet 10

4.14.11

1v/cm

5ms/cm

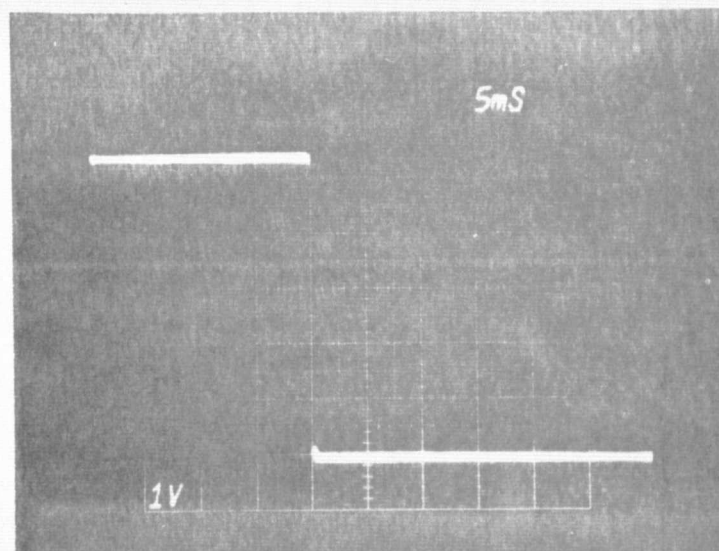


Sun  
Slit  
#1

4.14.11

1v/cm

5ms/cm



Sun  
Slit  
#2







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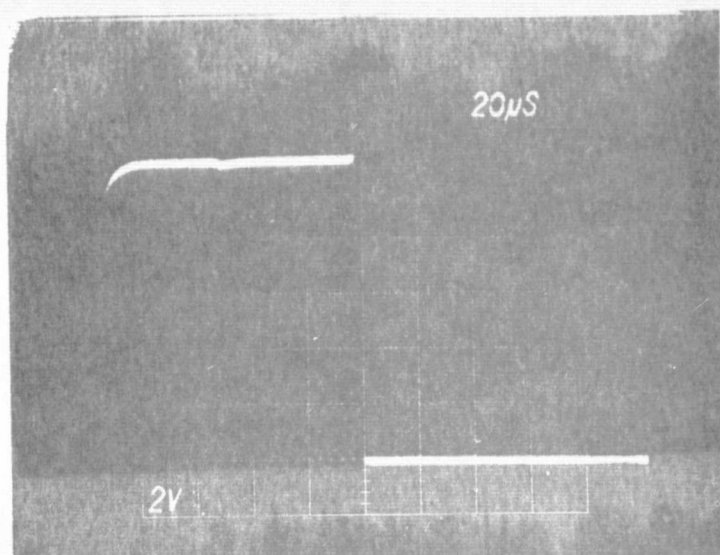
Data Sheet 11

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4.14.17

2v/cm

20ms/cm



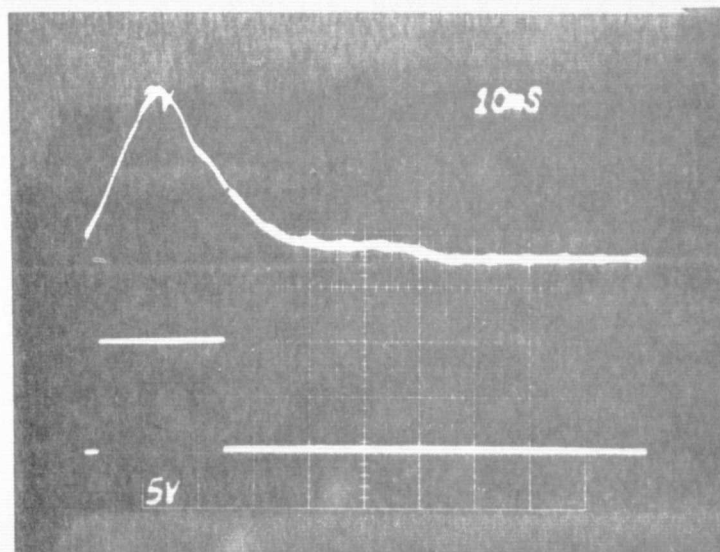
10v  
Sun  
Pulse

4.14.21

2v/cm

5v/cm

10ms/cm



Sun  
Slit  
Analog

Sun  
Slit







Data Sheet 12

4.14.22 Sun Slit Amplitude

$V_{pk} = 7$  volts Reference only

$\frac{V_{pk}}{2} = \frac{7}{2} = 3.5$  volts Reference only

4.14.23 Sun Slit Failure Edge

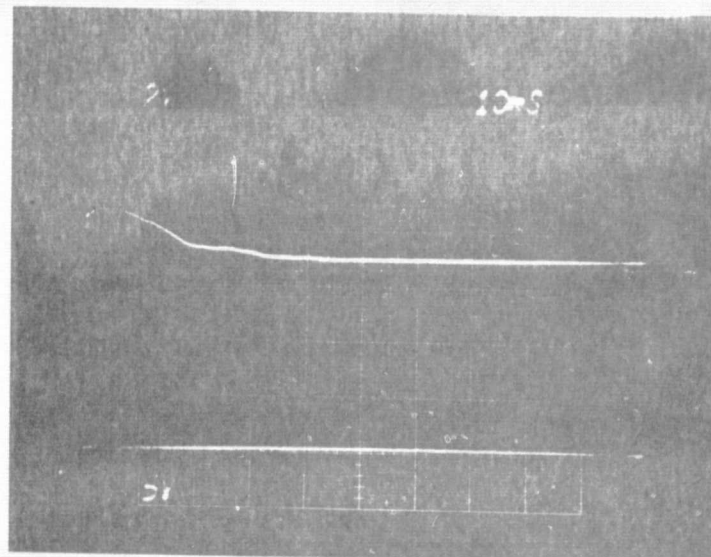
3.5 Volts, Requirement:  $\frac{V_{pk}}{2} \pm 0.5V$

4.14.24 Minimum Threshold Photo

2v/cm

5v/cm

5ms/cm



Sun Slit  
Analog

Sun  
Slit

4.14.25 Minimum Threshold Measurement

2.30 Volts, Requirement  $2.25 \pm 0.5V$



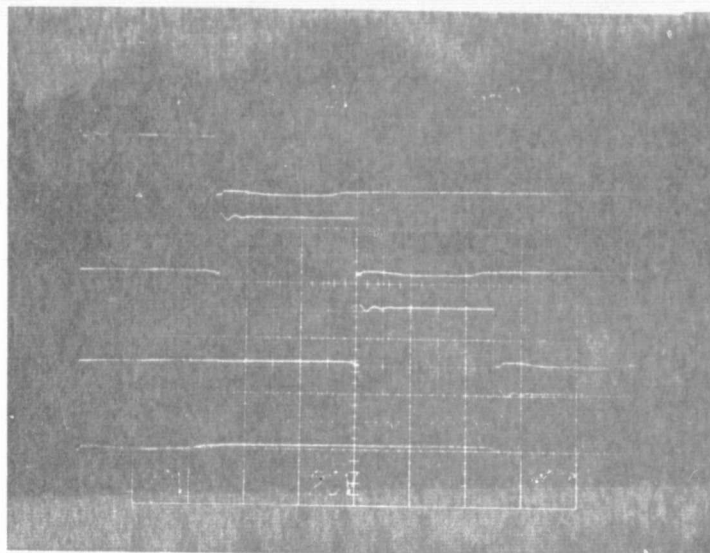
Data Sheet 13

4.14.28 Motor Drive Pulses

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20v/cm

5ms/cm

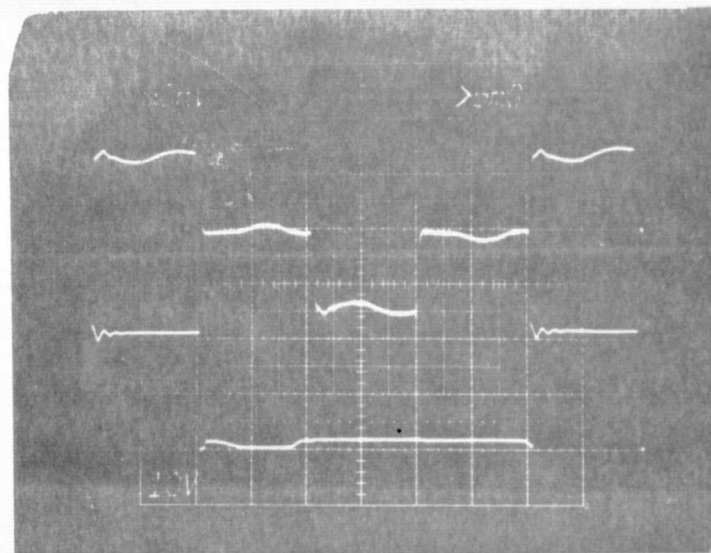


4.14.33  $\Phi A$  Current Photograph

100mA/cm

10v/cm

6ms/cm



4A motor  
current

4A motor  
voltage







Data Sheet 14

4.14.35  $\Phi A$  Current Measurement

Measurement

285 mA

Requirement

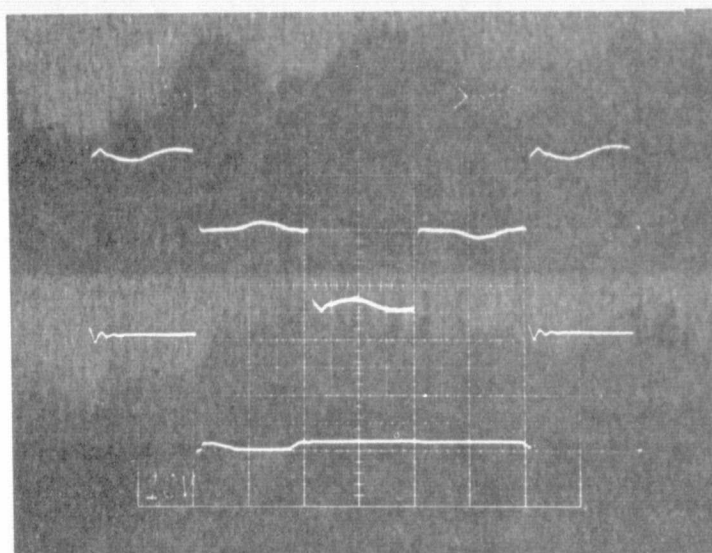
300 mA max excluding spikes

4.14.37  $\Phi B$  Current Photograph

100mA/cm

10v/cm

6ms/cm



4A motor  
voltage

4B motor  
current

4.14.38  $\Phi B$  Current Measurement

Measurement

285 mA

Requirement

300 mA max excluding spikes

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## Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt<br>Angle<br>(degrees) | Peak<br>Amplitude<br>(volts) | (1)<br>-Az Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Az Angle<br>at 1/2 PK Amp<br>(degrees) |
|----------------------------|------------------------------|------------------------------------------------|------------------------------------------------|
|                            |                              |                                                |                                                |
| +1.00                      | —                            | —                                              | —                                              |
| 0.75                       | —                            | —                                              | —                                              |
| 0.50                       | 1.95V                        | -91°                                           | +87°                                           |
| 0.25                       | 3.85V                        | -91°                                           | +90°                                           |
| 0.0                        | 4.45V                        | -91°                                           | +91°                                           |
| -0.25                      | 2.55V                        | -91°                                           | +91°                                           |
| -0.50                      | —                            | —                                              | —                                              |
| -0.75                      | —                            | —                                              | —                                              |
| -1.00                      | —                            | —                                              | —                                              |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

☒ Check



## Data Sheet 16

4.15.8,10

Transcribe the 2-axis table settings and complete the following table.

| Azimu<br>Azimuth<br>Angle<br>(degrees) | Space Corrected<br>Peak<br>Amplitude<br>(volts) | (1)<br>-Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | FOV    |
|----------------------------------------|-------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------|
| -90.85                                 | 6.08                                            | $\epsilon^- = -0.183^\circ$                      | $\epsilon^+ = +0.483^\circ$                      | 0.667° |
| -45                                    | 7.60                                            | $-0.233^\circ$                                   | $+0.442^\circ$                                   | 0.675° |
| 0                                      | 7.69                                            | $\xi^- = -0.342^\circ$                           | $\xi^+ = +0.342^\circ$                           | 0.683° |
| +45                                    | 7.97                                            | $-0.342^\circ$                                   | $+0.333^\circ$                                   | 0.675° |
| 90.85                                  | 6.17                                            | $\eta^- = -0.352^\circ$                          | $\eta^+ = +0.342^\circ$                          | 0.667° |

The sun sensor field of view (|column 1 - column 2|) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

Check

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\xi^- + \xi^+)}{2}$$

$$= 0.000^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(-\epsilon_+ + \epsilon_- + \eta_- + \eta_+)}{4}$$

$$= -0.310^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge trip point offset  $+0.342^\circ$

Reference only

REF WAIVER





## Data Sheet 17

4.16.7

- Transcribe the 2-axis table settings and complete the following table and calculate the Azimuth Field of View (FOV = | column 4 - column 3 |).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Azimuth Angle<br>1/2 Pk. Amp. | Positive<br>Azimuth Angle<br>1/2 Pk. Amp. | Azimuth<br>FOV*                 | Require-<br>ment |
|--------------------------------|--------------------|-------------------------------------------|-------------------------------------------|---------------------------------|------------------|
| 000                            | 0° (x-axis)        | $\alpha_1 = -0.498$                       | $\alpha_2 = 0.190$                        | $ \alpha_2 - \alpha_1  = 0.688$ | 0.71 ± 0.05°     |
| 128                            | 90°                | $\beta_1 = -0.505$                        | $\beta_2 = 0.186$                         | $ \beta_2 - \beta_1  = 0.691$   | 0.71 ± 0.05°     |
| 256                            | 180°               | $\gamma_1 = -0.530$                       | $\gamma_2 = 0.155$                        | $ \gamma_2 - \gamma_1  = 0.685$ | 0.71 ± 0.05°     |
| 384                            | 270° (y-axis)      | $\delta_1 = -0.562$                       | $\delta_2 = 0.131$                        | $ \delta_2 - \delta_1  = 0.692$ | 0.71 ± 0.05°     |

\* The scanner Field of View shall be 0.71° ± 0.05° at 50% of the peak amplitude.

- Calculate the Zero Scan Angle Error using the following equation:

$$\text{Error} = \frac{|\alpha_2 + \alpha_1|}{2}$$

$$\text{Error} = 0.154^\circ$$

Requirement

$$0^\circ \pm 0.7^\circ$$

- Calculate the scanner position accuracy according to the equations below:

| Encoder<br>Position | Reference<br>Angle | Error                                                         | Requirement |
|---------------------|--------------------|---------------------------------------------------------------|-------------|
| 128                 | 90°                | $(\alpha_1 + \alpha_2 - \beta_1 - \beta_2)/2 = 0.006^\circ$   | + 0.1°      |
| 256                 | 180°               | $(\alpha_1 + \alpha_2 - \gamma_1 - \gamma_2)/2 = 0.034^\circ$ | + 0.1°      |
| 384                 | 270°               | $(\alpha_1 + \alpha_2 - \delta_1 - \delta_2)/2 = 0.062^\circ$ | + 0.1°      |



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### Data Sheet 18

4.16.9

- Transcribe the 2-axis table readings to the following table and calculate the Elevation Field of View (FOV= |column 4 - column 3|).

| Scanner Encoded Position | Reference Angle | Negative Elevation Angle<br>1/2 Pk. amp | Positive Elevation Angle<br>1/2 Pk. amp | Elevation FOV*                  | Requirement           |
|--------------------------|-----------------|-----------------------------------------|-----------------------------------------|---------------------------------|-----------------------|
| 000                      | 0° (x-axis)     | $\alpha_- = -0.608$                     | $\alpha_+ = 0.092$                      | $ \alpha_+ - \alpha_-  = 0.700$ | $0.71 \pm 0.05^\circ$ |
| 128                      | 90°             | $\beta_- = -0.633$                      | $\beta_+ = 0.050$                       | $ \beta_+ - \beta_-  = 0.683$   | $0.71 \pm 0.05^\circ$ |
| 256                      | 180°            | $\gamma_- = -0.608$                     | $\gamma_+ = 0.083$                      | $ \gamma_+ - \gamma_-  = 0.692$ | $0.71 \pm 0.05^\circ$ |
| 384                      | 270° (y-axis)   | $\delta_- = -0.592$                     | $\delta_+ = 0.117$                      | $ \delta_+ - \delta_-  = 0.708$ | $0.71 \pm 0.05^\circ$ |

\*The scanner field of view shall be  $0.71^\circ \pm 0.05^\circ$  at 50% of the peak amplitude.

- Calculate the tilt angle ( $\phi$  in Figure 13) of the plane of the scanner optical axis with respect to the plane of the mounting surface using the following equation.

$$\phi = \tan^{-1} \left( \frac{|\sqrt{\alpha^2 + \beta^2 + \gamma^2 + \delta^2 - 2\alpha\gamma - 2\beta\delta}|}{2} \right)$$

where:  $\alpha = \tan(\alpha_+ + \alpha_-)/2$

$\beta = \tan(\beta_+ + \beta_-)/2$

$\gamma = \tan(\gamma_+ + \gamma_-)/2$

$\delta = \tan(\delta_+ + \delta_-)/2$

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0.027 " Requirement 0.020

- Calculate the direction of maximum tilt response with respect to the zero reference angle ( $\theta$  in Figure 13) using the following equation:

$$\theta = \tan^{-1} \frac{(\delta - \beta)}{(\gamma - \alpha)} = \left| \frac{(\delta - \beta)}{(\gamma - \alpha)} \right| \cdot 90^\circ - \left| \frac{(\delta - \beta)}{(\gamma - \alpha)} \right| \cdot 90^\circ + 180^\circ$$

Reference

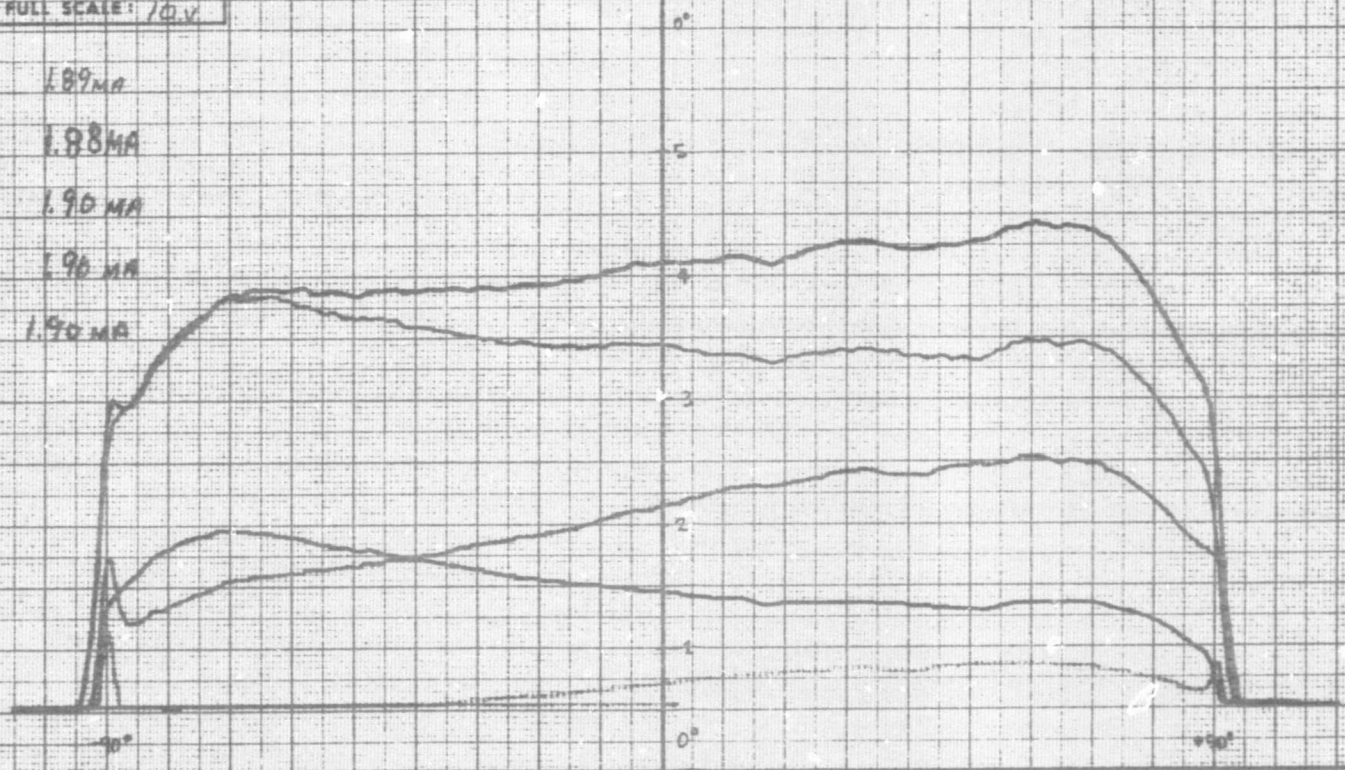
0 94.4

# SENSOR DATA BLOCK

|               |                   |               |         |
|---------------|-------------------|---------------|---------|
| BLOCK S/N:    | 004               | DATE:         | 9/15/76 |
| SENSOR:       | PAS               |               |         |
| DESC          | FINAL PERFORMANCE |               |         |
| PAGE          | 41.15.7           | TEMP          |         |
| SENSOR PEAK:  |                   |               |         |
| SOLAR PEAK:   |                   |               |         |
| SPACE PEAK:   |                   |               |         |
| SPACE GAIN:   |                   | HULL          |         |
| X FULL SCALE: | 2/50°             | Y FULL SCALE: | 10.V    |

0° Black 1.89 MA  
 +1/4° MAROON 1.88 MA  
 +1/2° RED 1.90 MA  
 -1/4° BLUE 1.90 MA  
 -1/2° GREEN 1.90 MA

Mike Hocking 9/16  
 J. H. Miller 9/16



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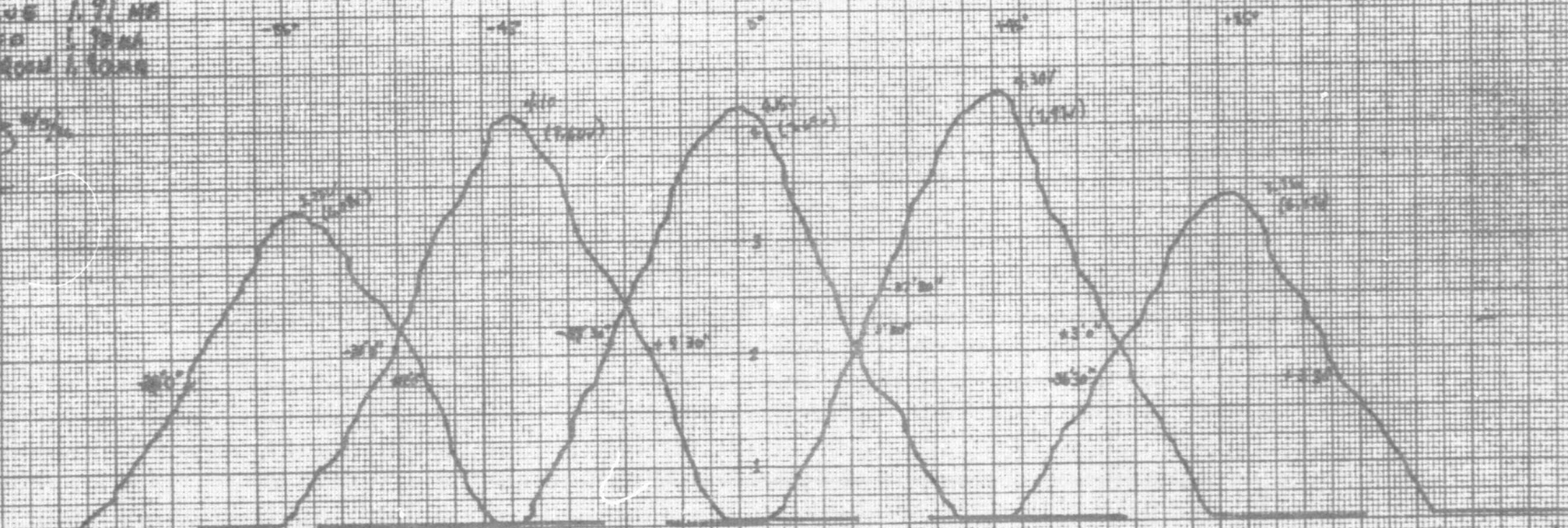


# SENSOR DATA BLOCK

|                          |              |
|--------------------------|--------------|
| BLOCK S/N: 004           | DATE: 5/6/76 |
| SENSOR: PAS              |              |
| DISC: Sun Sit For R 4.15 |              |
| From Resonance TRAP      |              |
| SOLAR PEAK:              |              |
| SPACE PEAK:              |              |
| SPACE GAIN: 100%         |              |
| K FULL SCALE: 10/div     |              |
| V FULL SCALE: 1V/div     |              |

0° Black 1.80mV  
 +45° Green 1.90mV  
 +85° Blue 1.91mV  
 -45° Red 1.80mV  
 -85° Magenta 1.80mV

At 4.15mV  
 1.80mV  
 1.90mV



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# SENSOR DATA BLOCK

|                                          |               |
|------------------------------------------|---------------|
| BLOCK S/N: 009                           | DATE: 8/16/76 |
| SENSOR: PPS                              |               |
| DEG ELEVATION: 4.16.9                    |               |
| TEMP:                                    |               |
| SENSOR PEAK:                             |               |
| SOLAR PEAK:                              |               |
| SPACE PEAK:                              |               |
| SPACE GAIN: NULS:                        |               |
| X FULL SCALE: 10/10V Y FULL SCALE: 1V/IN |               |

FINAL PERFORMANCE

SEE NDR #43001

REF 0 = 1° 6' 0"

0° - 1° 29' 30"  
+ 2° 11' 30"

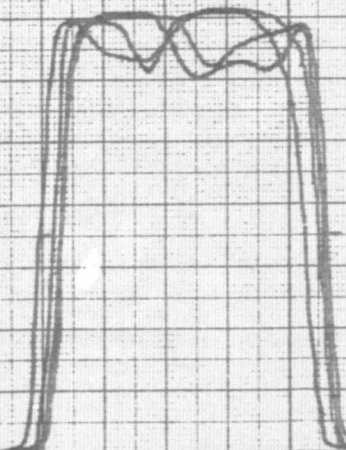
90° - 1° 28' 0"  
+ 2° 9' 0"

180° - 1° 29' 30"  
+ 2° 11' 0"

270° - 1° 30' 30"  
+ 2° 13' 00"

Mike Maiting 8/16  
Pat Hester 8-76

0-0 Reference



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# SENSOR DATA BLOCK

|                         |                     |
|-------------------------|---------------------|
| BLOCK S/N: 004          | DATE: 8/5/76        |
| SENSOR: PAS             |                     |
| DESC: AZIMUTH 4.16.7    |                     |
| Final Performance TEMP: |                     |
| SENSOR PEAK:            |                     |
| SOLAR PEAK:             |                     |
| SPACE PEAK:             |                     |
| SPACE GATE: NULL        |                     |
| X FULL SCALE: 10"/DIV   | Y FULL SCALE: 1"/IN |

Ref 275° 00' 00"

0° 274° 30' 09"  
275° 11' 26"

90° 4° 29' 41"  
5° 11' 09"

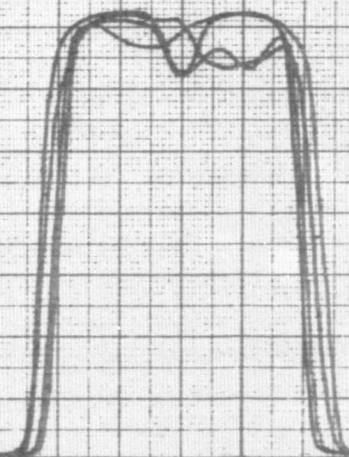
180° 94° 28' 11"  
95° 9' 18"

270° 184° 26' 18"  
185° 07' 50"

John Smith 7/1/76  
Pat Houston 8-5-76

(-)

O-O Reference



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BOULDER, COLORADO 80302

DOC NO 49959

DATE

CODE IDENT NO 13993

SHEET 54

REV A

## Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Performance-Panoramic Attitude Sensor, 49959.

## 3.2 SERIAL NUMBER

- Scanner head serial number 005
- Main Electronics serial number 005

## 3.3 TEST OPERATOR

- Signature of test operator D. L. McDaniel
- Date of start of test 11-29-76
- Date of end of test 12-1-76

## 3.4 EQUIPMENT REQUIRED

- Visicorder, Honeywell 1508, S/N 5401, Cal. Due N/R
- High Voltage Power Supply, Fluke 301C or equivalent  
N/R S/N B9808
- Oscilloscope with camera, Tektronix 547 or equivalent  
7633 S/N C9121, Cal. date 2-12-77
- Current probe, Tektronix P6042 or equivalent N/A,  
S/N C7543, Cal. date 5-12-77
- DVM, H-P 3440 or equivalent HP3465A, S/N C9255,  
Cal. date 1-1-77
- Current Meter, Weston 911 or equivalent N/A,  
S/N B3217, Cal. date 1-2-77
- VOM, Simpson 270 or equivalent HP3465A,  
S/N C9255, Cal. date 1-1-77
- Precision power supply, H-P 6114A or equivalent N/A,  
S/N C8792, Cal. date 1-22-77
- Pulse generator, Tektronix 2101 or equivalent N/A,  
S/N C8226, Cal. date 5-10-77
- X-Y Plotter, H-P 7047A or equivalent N/A,  
S/N C8968, Cal. date 2-10-77
- Dividing Head, 2 axis, Leitz Imperial Series 72 or  
equivalent N/A, S/N B12611, Cal. date 1-12-77

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CODE IDENT NO 13993

SHEET 55 REV \_\_\_\_\_

## Data Sheet 2

3.6.1 Self Check

Check ☒

3.6.2 Test Set Supply Voltages

| FUNCTION | MEASUREMENT   | REQUIREMENT |
|----------|---------------|-------------|
| +28v     | <u>.68</u> mA | 0.7 + 0.07  |
| +12v     | <u>.60</u> mA | 0.6 + 0.06  |
| +10v     | <u>.48</u> mA | 0.5 + 0.05  |
| + 8v     | <u>.82</u> mA | 0.8 + 0.08  |
| + 5v     | <u>.50</u> mA | 0.5 + 0.05  |
| - 5v     | <u>.54</u> mA | 0.5 + 0.05  |

4.1.1 Ground Continuity

| Measure from<br>Pin to Pin    | Function     | Measurement    | Requirement |
|-------------------------------|--------------|----------------|-------------|
| 20 Electronics box<br>chassis | CHASSIS GND. | <u>.09</u> Ohm | <0.2 Ohms   |
| 20 21                         | CHASSIS GND. | <u>.04</u> Ohm | <0.2 Ohms   |
| 17 19                         | 28v Ret.     | <u>.16</u> Ohm | <0.2 Ohms   |
| 12 13                         | SIG. GND.    | <u>.17</u> Ohm | <0.2 Ohms   |

4.1.2 Ground Isolation

| Measure from<br>Pin to Pin | Function  | Measurement        | Requirement     |
|----------------------------|-----------|--------------------|-----------------|
| 20 12                      | SIG. GND. | <u>&gt;10M</u> Ohm | >100 k $\Omega$ |
| 20 17                      | 28v Ret.  | <u>&gt;10M</u> Ohm | >100 k $\Omega$ |

4.2.1 Thermistor Continuity

| Measure from<br>Pin to Pin | Function                     | Measurement              | Requirement        |
|----------------------------|------------------------------|--------------------------|--------------------|
| 14 15                      | Elect. Thms. 1 ( $R_{et1}$ ) | <u>10.867</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 33 34                      | Elect. Thms. 2 ( $R_{et2}$ ) | <u>10.943</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 35 36                      | Scan. Thms. 1 ( $R_{st1}$ )  | <u>10.915</u> k $\Omega$ | 5k to 15k $\Omega$ |
| 37 5                       | Scan. Thms. 2 ( $R_{st2}$ )  | <u>10.900</u> k $\Omega$ | 5k to 15k $\Omega$ |



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CODE IDENT NO 13993

SHEET 56 REV \_\_\_\_\_

### Data Sheet 3

#### 4.2.2 Electronics Thermistor Resistance

$$\Delta R = \frac{(R_{et1} - R_{et2}) \times 100\%}{R_{et1}} = \frac{(10.867 \text{ k}\Omega - 10.943 \text{ k}\Omega) \times 100\%}{10.867 \text{ k}\Omega}$$

$$R_{et1} = \frac{0.70}{10.867} \% \approx 0.0064\%$$

Requirement:  $\pm 4\%$

#### 4.2.3 Scanner Thermistor Resistance

$$\Delta R = \frac{(R_{st1} - R_{st2}) \times 100\%}{R_{st1}} = \frac{(10.915 \text{ k}\Omega - 10.900 \text{ k}\Omega) \times 100\%}{10.915 \text{ k}\Omega}$$

$$R_{st1} = \frac{0.14}{10.915} \% \approx 0.0128\%$$

Requirement:  $\pm 4\%$

#### 4.2.4 Thermistor Isolation

| Measure from<br>Pin to Pin |    | Function       | Measurement             | Requirement    |
|----------------------------|----|----------------|-------------------------|----------------|
| 14                         | 20 | Elect. Thms. 1 | <u>21000</u> k $\Omega$ | >100k $\Omega$ |
| 34                         | 20 | Elect. Thms. 2 | <u>21000</u> k $\Omega$ | >100k $\Omega$ |
| 35                         | 20 | Scan. Thms. 1  | <u>21000</u> k $\Omega$ | >100k $\Omega$ |
| 37                         | 20 | Scan. Thms. 2  | <u>21000</u> k $\Omega$ | >100k $\Omega$ |

#### 4.3.3 Initial Turn On

Check 6-

#### 4.4.3 Idle Input Current

| Function                          | Measurement    | Requirement     |
|-----------------------------------|----------------|-----------------|
| 28v input current<br>( $I_{in}$ ) | <u>43.5</u> mA | 50mA $\pm$ 25mA |
| 28v input voltage<br>( $E_{in}$ ) | <u>28.05</u> V | 28V $\pm$ 0.28V |

#### 4.4.4 Idle Input Power

$$P_i = E_{in} \times I_{in}$$

$$= 28.05 \text{ V} \times 43.5 \text{ mA}$$

$$= 1220 \text{ mW. Reference reading only.}$$

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DOC NO 49959

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CODE IDENT NO 13993

SHEET \_\_\_\_\_

57

REV \_\_\_\_\_

## Data Sheet 4

4.4.6 Scanner Rotation

Check L

4.4.7 Running Power

FunctionMeasurement28v input current  
( $I_{in}$ )160 <sup>mA</sup> <sup>11-24-76</sup>  
28.00 mA Reference only28v input voltage  
( $E_{in}$ )28.00 V Reference only

$$P_r = E_{in} \times I_{in}$$

$$= 28.00 \text{ V} \times 160 \text{ mA}$$

$$= 4480 \text{ mW}$$

Requirement &lt;5.0 watts

4.4.11 Main Electronics Power

FunctionMeasurement28v input current  
( $I_{in}$ )26.6 mA Reference only28v input voltage  
( $E_{in}$ )28.09 V Reference only

$$P_e = E_{in} \times I_{in}$$

$$= 28.09 \text{ V} \times 26.6 \text{ mA}$$

$$P_c = 747 \text{ mW}$$

Requirement &lt;1.0 watts

4.5 Power On Initialize

4.5.3 ✓ Check4.5.5 ✓ Check

$$4.5.7 \quad \text{OFFSET} = \frac{\text{AOS1} + \text{LOS1} + \text{AOS2} + \text{LOS2} + \text{AOS3} + \text{LOS3} - 1060}{6}$$

$$\text{OFFSET} = \underline{.33}$$

Requirement: ± 34.5.8 ✓ Check4.5.9 ✓ Check

58  
11/20/76





## Data Sheet 5

## 4.6.1 Analog Telem Calibration

Measure from  
Pin to Pin

Function

Measurement

Requirement

|    |    |              |                |            |
|----|----|--------------|----------------|------------|
| 12 | 9  | + 5v MONITOR | <u>4.230</u> V | 4.0 + 1.0V |
| 12 | 10 | +20v MONITOR | <u>4.160</u> V | 4.0 + 1.0V |

## 4.7.2 Scanner Revolution Rate

Rate (R)

Rate Readout

Measured Time

Nominal Time

|   |          |                 |          |
|---|----------|-----------------|----------|
| 0 | <u>0</u> | <u>54</u> sec.  | 52 sec.  |
| 1 | <u>1</u> | <u>26</u> sec.  | 26 sec.  |
| 2 | <u>2</u> | <u>13</u> sec.  | 13 sec.  |
| 3 | <u>3</u> | <u>6.5</u> sec. | 6.5 sec. |

## 4.8 Invalid Data Test

4.8.1 ✓ Check4.8.2 ✓ Check

## 4.9 CW-CCW Test

4.9.2 ✓ Check4.9.4 ✓ Check4.9.5 ✓ Check4.9.6 ✓ Check4.9.7 ✓ Check

## 4.10 Sector Test

4.10.2 ✓ Check4.10.3 ✓ Check4.10.4 ✓ Check4.10.5 ✓ Check4.10.6 ✓ Check4.10.7 ✓ Check4.10.8 ✓ Check4.10.9 ✓ Check4.10.10 ✓ Check

11/30/76  
MJP

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SHEET 50 REV

## Data Sheet 6

|         |          |       |
|---------|----------|-------|
| 4.10.11 | <u>✓</u> | Check |
| 4.10.12 | <u>✓</u> | Check |
| 4.10.13 | <u>✓</u> | Check |
| 4.10.14 | <u>✓</u> | Check |
| 4.10.15 | <u>✓</u> | Check |
| 4.10.16 | <u>✓</u> | Check |
| 4.10.17 | <u>✓</u> | Check |
| 4.10.18 | <u>✓</u> | Check |
| 4.10.19 | <u>✓</u> | Check |
| 4.10.20 | <u>✓</u> | Check |
| 4.10.21 | <u>✓</u> | Check |
| 4.10.22 | <u>✓</u> | Check |
| 4.10.23 | <u>✓</u> | Check |
| 4.10.24 | <u>✓</u> | Check |
| 4.10.25 | <u>✓</u> | Check |
| 4.10.26 | <u>✓</u> | Check |
| 4.10.27 | <u>✓</u> | Check |
| 4.10.28 | <u>✓</u> | Check |
| 4.10.29 | <u>✓</u> | Check |
| 4.10.30 | <u>✓</u> | Check |
| 4.10.31 | <u>✓</u> | Check |
| 4.10.32 | <u>✓</u> | Check |
| 4.10.33 | <u>✓</u> | Check |
| 4.10.34 | <u>✓</u> | Check |
| 4.10.35 | <u>✓</u> | Check |
| 4.10.36 | <u>✓</u> | Check |
| 4.10.37 | <u>✓</u> | Check |

*imp*  
1/30/76

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DATE \_\_\_\_\_  
SHEET 60 REV \_\_\_\_\_

## Data Sheet 7

4.11.6 Sector Check

Check ☒

4.11.7 Power Supply Variation

POWER  
SUPPLYAOS/LOS  
DISPLAY0  
READOUT26.60  $\pm$  0.26v (-4%)☒☒28.84  $\pm$  0.28v (+2%)☒☒28.00  $\pm$  0.28v (NOM)☒☒

4.11.9 Clock Frequency Variations

Frequency at FailureRequirementUpper 14.1 MHz

&gt;12.9 MHz

Lower 5 MHz

&lt;10.0 MHz

4.12 Slow Data Rate

4.12.5 ☒ Check4.12.6 ☒ Check4.12.7 ☒ Check4.12.8 ☒ Check4.12.9 ☒ Check4.12.10 ☒ Check4.12.11 ☒ Check4.12.12 ☒ Check

4.13 Spherical Mode Check

4.13.4 ☒ Check4.13.5 ☒ Check4.13.6 ☒ Check4.13.7 ☒ Check4.13.8 ☒ Check4.13.9 ☒ Check4.13.10 ☒ Check



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SHEET 61 REV           

Data Sheet 8

|         |          |       |
|---------|----------|-------|
| 4.13.11 | <u>✓</u> | Check |
| 4.13.12 | <u>✓</u> | Check |
| 4.13.13 | <u>✓</u> | Check |
| 4.13.14 | <u>✓</u> | Check |
| 4.13.15 | <u>✓</u> | Check |
| 4.13.16 | <u>✓</u> | Check |
| 4.13.17 | <u>✓</u> | Check |
| 4.13.18 | <u>✓</u> | Check |
| 4.13.19 | <u>✓</u> | Check |
| 4.13.20 | <u>✓</u> | Check |
| 4.13.21 | <u>✓</u> | Check |
| 4.13.22 | <u>✓</u> | Check |
| 4.13.23 | <u>✓</u> | Check |
| 4.13.24 | <u>✓</u> | Check |
| 4.13.25 | <u>✓</u> | Check |
| 4.13.26 | <u>✓</u> | Check |
| 4.13.27 | <u>✓</u> | Check |
| 4.13.28 | <u>✓</u> | Check |
| 4.13.29 | <u>✓</u> | Check |
| 4.13.30 | <u>✓</u> | Check |
| 4.13.31 | <u>✓</u> | Check |
| 4.13.32 | <u>✓</u> | Check |
| 4.13.33 | <u>✓</u> | Check |
| 4.13.34 | <u>✓</u> | Check |
| 4.13.35 | <u>✓</u> | Check |
| 4.13.36 | <u>✓</u> | Check |



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SHEET 62 REV A

Data Sheet 9

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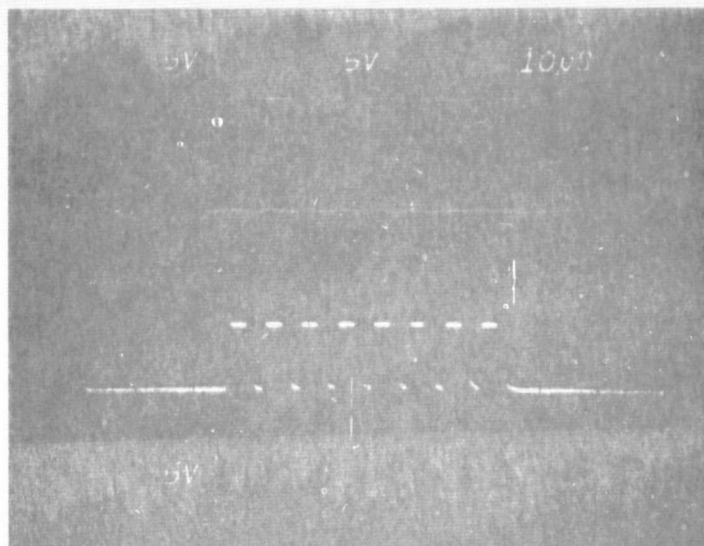
4.14.2

5v/cm

5v/cm

5v/cm

10 $\mu$ s/cm



DWG

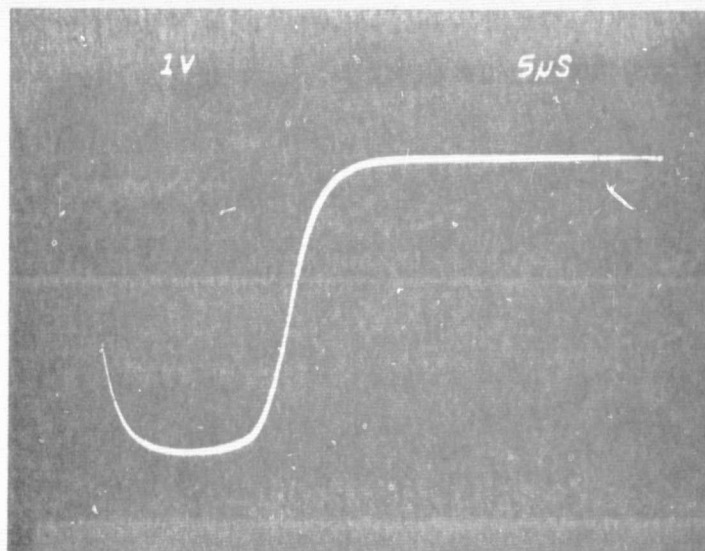
Burst  
Clock

Shift  
Pulses

4.14.6

1v/cm

5 $\mu$ s/cm



Load  
Pulse





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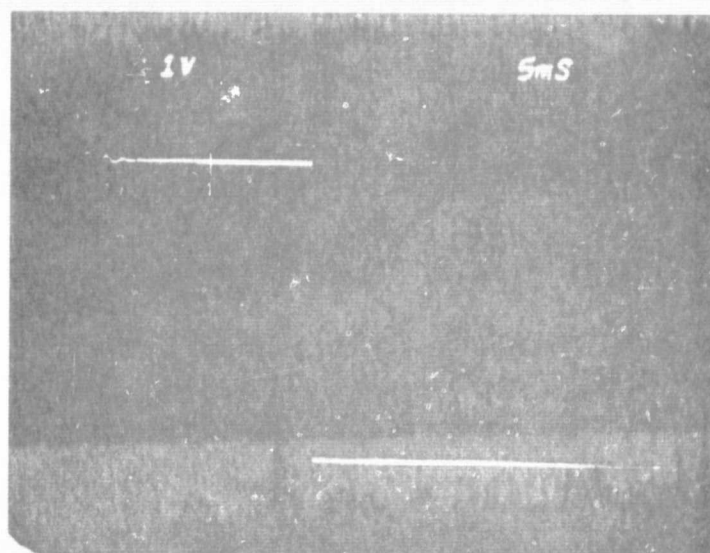
SHEET 63 REV

Data Sheet 10

4.14.11

1v/cm

5ms/cm

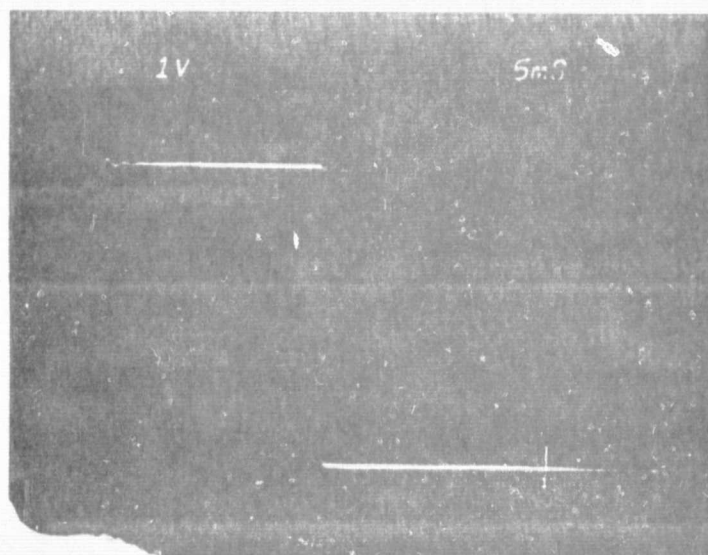


Sun  
Slit  
#1

4.14.14

1v/cm

5ms/cm



Sun  
Slit  
#2

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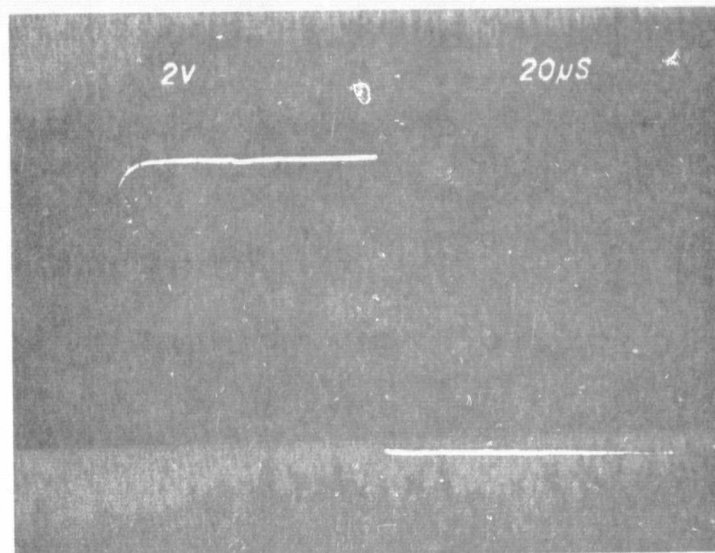
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DATE \_\_\_\_\_  
SHEET 64 REV \_\_\_\_\_

CODE IDENT NO 13993

Data Sheet 11

4.14.17

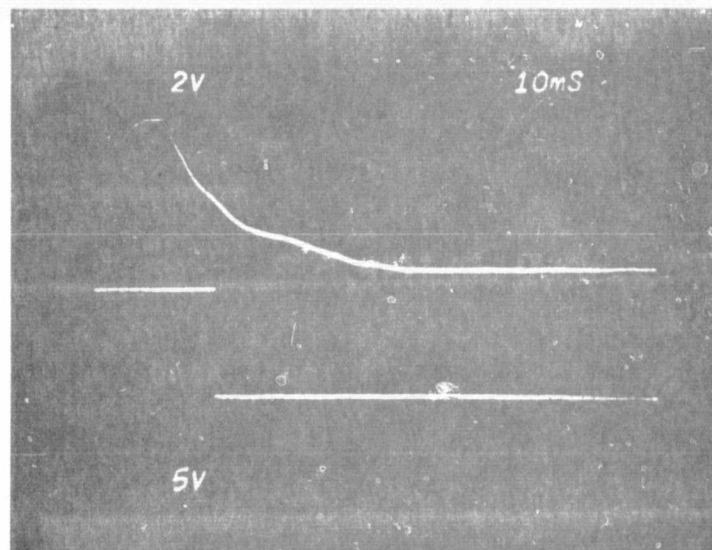
2v/cm  
20ms/cm



10v  
Sun  
Pulse

4.14.21

2v/cm  
5v/cm  
10ms/cm



Sun  
Slit  
Analog

Sun  
Slit

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SHEET 65

REV

Data Sheet 12

4.14.22 Sun Slit Amplitude

$V_{pk} = 6$  volts

Reference only

$\frac{V_{pk}}{2} = \frac{6}{2} = 3$  volts

Reference only

4.14.23 Sun Slit Failure Edge

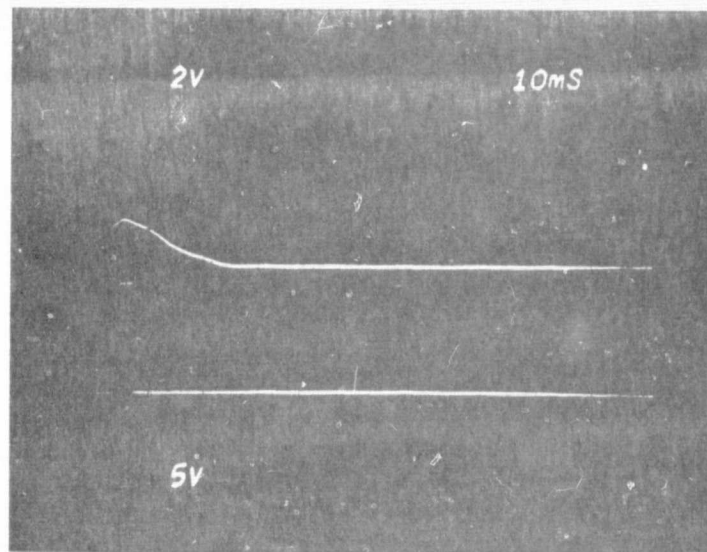
3.1 Volts, Requirement:  $\frac{V_{pk}}{2} \pm 0.5V$

4.14.24 Minimum Threshold Photo

2v/cm

5v/cm

5ms/cm



Sun Slit  
Analog

Sun  
Slit

4.14.25 Minimum Threshold Measurement

2.2 Volts, Requirement  $2.25 \pm 0.5V$





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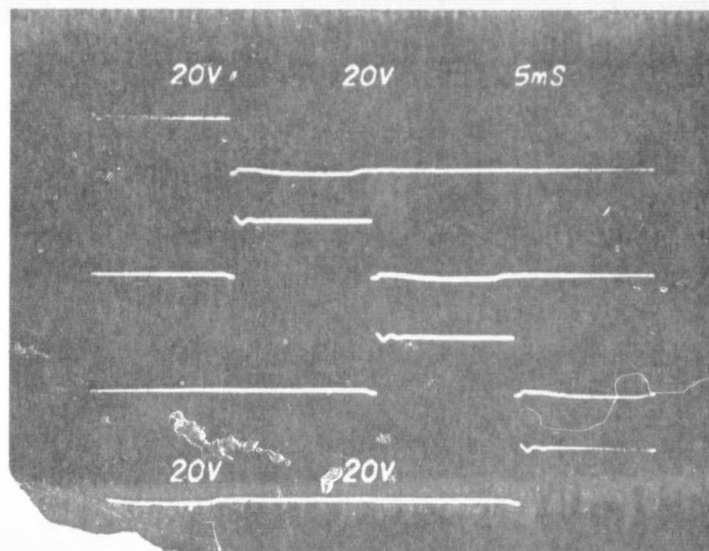
SHEET 66 REV

### Data Sheet 13

#### 4.14.28 Motor Drive Pulses

20v/cm

5ms/cm



$\Phi A$

$\Phi B$

$\Phi C$

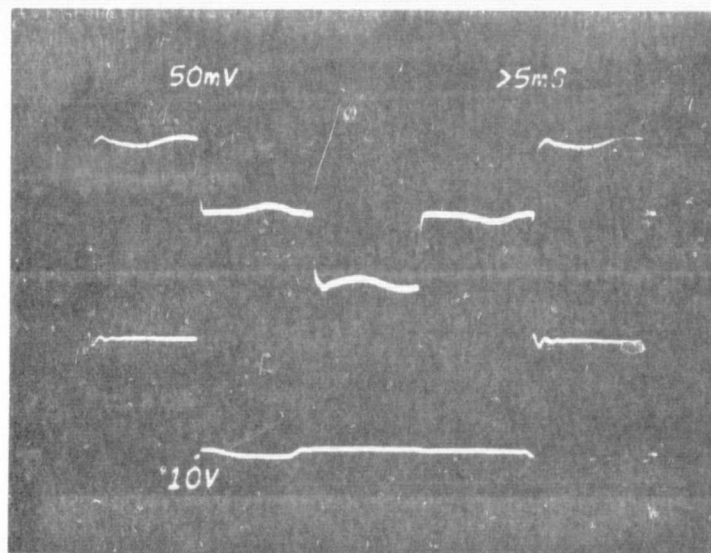
$\Phi D$

#### 4.14.33 $\Phi A$ Current Photograph

100mA/cm

10v/cm

~6ms/cm



$\Phi A$  motor  
current

$\Phi A$  motor  
voltage

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SHEET 67

REV

Data Sheet 14

4.14.35  $\Phi$ A Current Measurement

Measurement

260 mA

Requirement

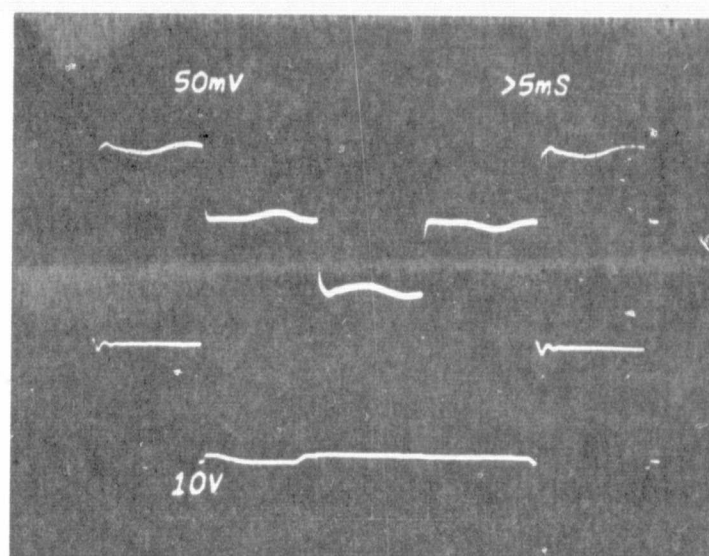
300 mA max excluding spikes

4.14.37  $\Phi$ B Current Photograph

100mA/cm

10V/cm

6ms/cm



$\Phi$ A motor  
voltage

$\Phi$ B motor  
current

4.14.38  $\Phi$ B Current Measurement

Measurement

260 mA

Requirement

300 mA max excluding spikes





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Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt Angle (degrees) | Peak Amplitude (volts) | (1)<br>-Az Angle at 1/2 PK Amp (degrees) | (2)<br>+Az Angle at 1/2 PK Amp (degrees) |
|----------------------|------------------------|------------------------------------------|------------------------------------------|
| +1.00                | —                      | —                                        | —                                        |
| 0.75                 | —                      | —                                        | —                                        |
| 0.50                 | 1.65                   | -91                                      | +91                                      |
| 0.25                 | 3.50                   | -91                                      | +91                                      |
| 0.0                  | 3.90                   | -91                                      | +91                                      |
| -0.25                | 2.40                   | -91                                      | +92                                      |
| -0.50                | 1.30                   | -91                                      | +91                                      |
| -0.75                | —                      | —                                        | —                                        |
| -1.00                | —                      | —                                        | —                                        |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

✓ Check



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# Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table.

| Azimuth Angle (degrees) | Space Corrected Peak Amplitude (volts) | (1) -Tilt Angle at 1/2 PK Amp (degrees) | (2) +Tilt Angle at 1/2 PK Amp (degrees) | F.O.V. (degrees) |
|-------------------------|----------------------------------------|-----------------------------------------|-----------------------------------------|------------------|
| -85                     | 5.01V.                                 | $\epsilon^- = -0.350$                   | $\epsilon^+ = +0.350$                   | 0.700            |
| -45                     | 5.36V.                                 | $\epsilon^- = -0.233$                   | $\epsilon^+ = +0.433$                   | 0.667            |
| 0                       | 5.38V.                                 | $\epsilon^- = -0.200$                   | $\epsilon^+ = +0.500$                   | 0.700            |
| +45                     | 5.80V.                                 | $\epsilon^- = -0.183$                   | $\epsilon^+ = +0.500$                   | 0.683            |
| 85                      | 5.71V.                                 | $\eta^- = -0.233$                       | $\eta^+ = +0.450$                       | 0.683            |

The sun sensor field of view (|column 1 - column 2|) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

50

Check

SEE MDR A30554

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\epsilon^- + \epsilon^+)}{2}$$

$$= +0.16^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

SEE WAIVER # 013W.

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(\epsilon^+ + \epsilon^- + \eta^- + \eta^+)}{4}$$

$$= +0.054^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge Trip Point Offset

$$+0.500^\circ$$

Reference Only



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# Data Sheet 17

## 4.16.7

- Transcribe the 2-axis table settings and complete the following table and calculate the Azimuth Field of View (FOV = | column 4 - column 3|).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Azimuth Angle<br>1/2 Pk. Amp. | Positive<br>Azimuth Angle<br>1/2 Pk. Amp. | Azimuth<br>FOV*                 | Require-<br>ment      |
|--------------------------------|--------------------|-------------------------------------------|-------------------------------------------|---------------------------------|-----------------------|
| 000                            | 0° (x-axis)        | $\alpha_1 = -0.471$                       | $\alpha_2 = +0.227$                       | $ \alpha_2 - \alpha_1  = 0.699$ | $0.71 \pm 0.05^\circ$ |
| 128                            | 90°                | $\beta_1 = -0.456$                        | $\beta_2 = +0.246$                        | $ \beta_2 - \beta_1  = 0.703$   | $0.71 \pm 0.05^\circ$ |
| 256                            | 180°               | $\gamma_1 = -0.473$                       | $\gamma_2 = +0.226$                       | $ \gamma_2 - \gamma_1  = 0.699$ | $0.71 \pm 0.05^\circ$ |
| 384                            | 270° (y-axis)      | $\delta_1 = -0.500$                       | $\delta_2 = +0.201$                       | $ \delta_2 - \delta_1  = 0.701$ | $0.71 \pm 0.05^\circ$ |

\* The scanner Field of View shall be  $0.71^\circ \pm 0.05^\circ$  at 50% of the peak amplitude.

- Calculate the Zero Scan Angle Error using the following equation:

$$\text{Error} = \frac{|\alpha_2 + \alpha_1|}{2}$$

$$\text{Error} = \underline{0.122}^\circ$$

Requirement

$$0^\circ \pm 0.7^\circ$$

- Calculate the scanner position accuracy according to the equations below:

| Encoder<br>Position | Reference<br>Angle | Error                                                         | Requirement     |
|---------------------|--------------------|---------------------------------------------------------------|-----------------|
| 128                 | 90°                | $(\alpha_1 + \alpha_2 - \beta_1 - \beta_2)/2 = -0.017^\circ$  | $\pm 0.1^\circ$ |
| 256                 | 180°               | $(\alpha_1 + \alpha_2 - \gamma_1 - \gamma_2)/2 = 0.001^\circ$ | $\pm 0.1^\circ$ |
| 384                 | 270°               | $(\alpha_1 + \alpha_2 - \delta_1 - \delta_2)/2 = 0.027^\circ$ | $\pm 0.1^\circ$ |





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# Data Sheet 18

4.16.9

- Transcribe the 2-axis table readings to the following table and calculate the Elevation Field of View (FOV= |column 4 - column 3|).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Elevation<br>Angle<br>1/2 Pk. amp | Positive<br>Elevation<br>Angle<br>1/2 Pk. amp | Elevation<br>FOV*               | Require<br>ment |
|--------------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------|-----------------|
| 000                            | 0° (x-axis)        | $\alpha_- = -0.517$                           | $\alpha_+ = +0.200$                           | $ \alpha_+ - \alpha_-  = 0.717$ | 0.71±05°        |
| 128                            | 90°                | $\beta_- = -0.433$                            | $\beta_+ = +0.283$                            | $ \beta_+ - \beta_-  = 0.717$   | 0.71±05°        |
| 256                            | 180°               | $\gamma_- = -0.450$                           | $\gamma_+ = +0.267$                           | $ \gamma_+ - \gamma_-  = 0.717$ | 0.71±05°        |
| 384                            | 270° (y-axis)      | $\delta_- = -0.533$                           | $\delta_+ = +0.200$                           | $ \delta_+ - \delta_-  = 0.733$ | 0.71±05°        |

\*The scanner field of view shall be 0.71° ± 0.05° at 50% of the peak amplitude.

- Calculate the tilt angle ( $\phi$  in Figure 13) of the plane of the scanner optical axis with respect to the plane of the mounting surface using the following equation.

$$\phi = \tan^{-1} \left( \frac{|\sqrt{\alpha^2 + \beta^2 + \gamma^2 + \delta^2 - 2\alpha\gamma - 2\beta\delta}|}{2} \right)$$

where;  $\alpha = \tan (\alpha_+ + \alpha_-) / 2$

$\beta = \tan (\beta_+ + \beta_-) / 2$

$\gamma = \tan (\gamma_+ + \gamma_-) / 2$

$\delta = \tan (\delta_+ + \delta_-) / 2$

$\phi = 0.057^\circ$

Requirement

0° ± 2.0

- Calculate the direction of maximum tilt response with respect to the zero reference angle ( $\theta$  in Figure 13) using the following equation:

$$\theta = \tan^{-1} \frac{(\delta - \beta)}{(\gamma - \alpha)} - \left| \frac{(\delta - \beta)}{(\delta - \beta)} \frac{(\gamma - \alpha)}{(\gamma - \alpha)} \right| \cdot 90^\circ - \left| \frac{(\delta - \beta)}{(\delta - \beta)} \right| \cdot 90^\circ + 180^\circ \quad \text{Reference only}$$

$\theta = 306^\circ$



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Data Sheet 19

- Calculate the cone angle (average deviation from a plane) using the following equation:

$$\phi = \frac{(\alpha_- + \alpha_+ + \beta_- + \beta_+ + \gamma_- + \gamma_+ + \delta_- + \delta_+)}{8}$$

$$\phi = -0.123^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

- Calculate the maximum error using the following equation:

$$\text{error} = |\phi| + |\phi| = 0.110^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

4.16.13 Scanner Trip-On Point

Measured  $V_{\text{trip-on}}$

$$9.090 \text{ V}$$

Measured  $V_{\text{dark}}$

$$8.999 \text{ V}$$

% full space moon =

$$\frac{V_{\text{trip-on}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 9.3\%$$

Requirement

5% to 20%

4.16.15 Scanner Trip-Off Point

Measured  $V_{\text{trip-off}}$

$$9.085 \text{ V}$$

Measured  $V_{\text{dark}}$

$$8.999 \text{ V}$$

% full space moon =

$$\frac{V_{\text{trip-off}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 8.78\%$$

Requirement

5% to 20%

4.17.7 Backlash Test

Measured

$$0.069^\circ$$

Requirement

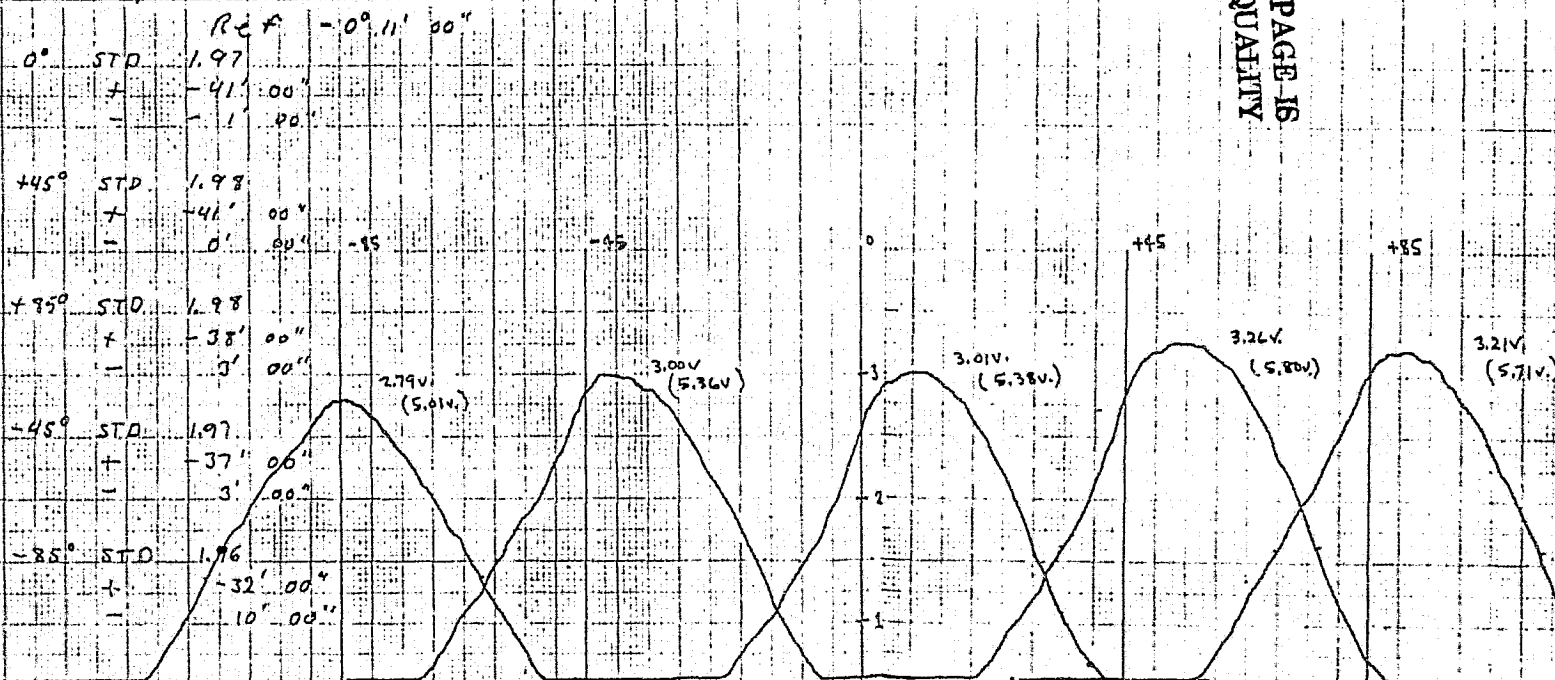
$$< 0.2^\circ$$



# SENSOR DATA BLOCK

|                                                 |               |
|-------------------------------------------------|---------------|
| BLOCK S/N: 005                                  | DATE: 12-1-76 |
| SENSOR: PAS                                     |               |
| DESC: P.P.T.                                    |               |
| SUN S/I                                         | TEMP:         |
| SENSOR PEAK:                                    |               |
| SOLAR PEAK:                                     |               |
| SPACE PEAK:                                     |               |
| SPACE GAIN:                                     | NULL          |
| X FULL SCALE: 10' / 100' FULL SCALE: 10' / 1' N |               |

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OF POOR QUALITY



RETAIN ORIGINAL RECORD COPY

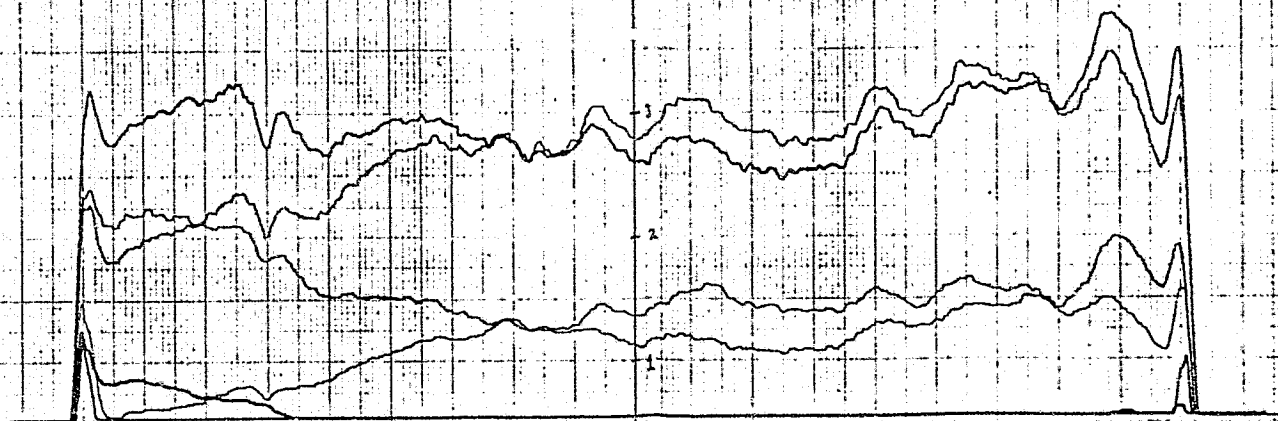
BR-147 8-68

# SENSOR DATA BLOCK

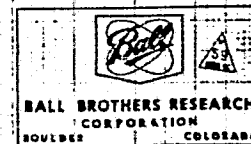
5-2

|                                            |  |               |  |
|--------------------------------------------|--|---------------|--|
| BLOCK S/N: 005                             |  | DATE: 12-1-76 |  |
| SENSOR: PAS                                |  |               |  |
| DESC: F.P.T.                               |  |               |  |
| SUN SLIT                                   |  | TEMP:         |  |
| SENSOR PEAK:                               |  |               |  |
| SOLAR PEAK:                                |  |               |  |
| SPACE PEAK:                                |  |               |  |
| SPACE GAIN:                                |  | NULL:         |  |
| X FULL SCALE: 10°/div Y FULL SCALE: 10°/in |  |               |  |

0° BIK STD 1.97  
 +.25° Red STD 1.96  
 +.50° MAROON STD 1.96  
 -.25° GRN STD 1.96  
 -.50° BLU STD 1.96



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BR-147 8-63

10 X 10 TO 1/2 INCH 47 1323

# SENSOR DATA BLOCK

5-3

|                                     |               |
|-------------------------------------|---------------|
| BLOCK S/N: 005                      | DATE: 11-30-2 |
| SENSOR: PAS                         |               |
| DESC: F.P.T                         |               |
| SCANNER EL:                         | TEMP:         |
| SENSOR PEAK:                        |               |
| SOLAR PEAK:                         |               |
| SPACE PEAK:                         |               |
| SPACE GAIN:                         | NULL:         |
| X SCALE: 10/4.0 Y FULL SCALE: 10/in |               |

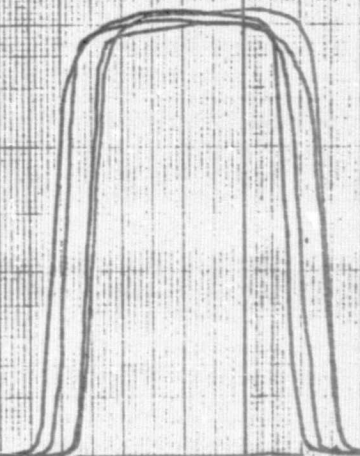
Ref 3° 9'

0° BLK - 2° 38'  
+ 3° 21'

90° Red - 2° 43'  
+ 3° 26'

180° GRN - 2° 42'  
+ 3° 25'

270° BLU - 2° 37'  
+ 3° 21'



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# SENSOR DATA BLOCK

54

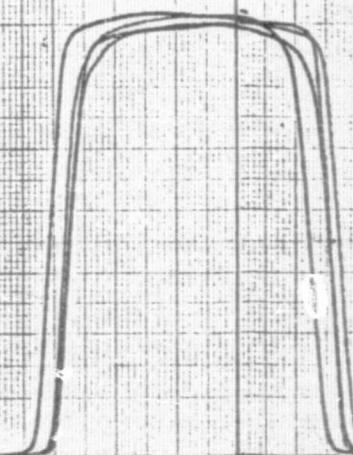
|                                              |                |
|----------------------------------------------|----------------|
| BLOCK S/N: 005                               | DATE: 11-30-76 |
| SENSOR: PAS                                  |                |
| DESC: F.P.T                                  |                |
| SCANNER: A2                                  | TEMP:          |
| SENSOR PEAK:                                 |                |
| SOLAR PEAK:                                  |                |
| SPACE PEAK:                                  |                |
| SPACE GAIN:                                  | NULL:          |
| X FULL SCALE: 10' 4.0" Y FULL SCALE: 10' 10" |                |

0° BLK Ref 220° 00' 00"  
 - 217° 31' 43"  
 + 220° 23' 34"

70° Red Ref 310° 00' 00"  
 - 307° 32' 37"  
 + 310° 14' 47"

130° GRN Ref 040° 00' 00"  
 - 39° 31' 38"  
 + 40° 13' 33"

270° BLU Ref 130° 00' 00"  
 129° 30' 00"  
 130° 13' 03"



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BB-147 0-00

10 X 10 TO 1/4 INCH 47 1323  
 10 X 15 INCHES  
 K-E  
 KUTTER & BERRY CO



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REV A

Data Sheet 1

Paragraph numbers correspond with paragraph numbers of Test Procedure, Performance-Panoramic Attitude Sensor, 49959.

3.2 SERIAL NUMBER

- Scanner head serial number 006
- Main Electronics serial number 006

3.3 TEST OPERATOR

- Signature of test operator G. L. McDaniel
- Date of start of test 11-29-76
- Date of end of test 12-1-76

3.4 EQUIPMENT REQUIRED

- Visicorder, Honeywell 1508, S/N 5401, Cal. Due N/A
- High Voltage Power Supply, Fluke 301C or equivalent  
N/A S/N B9808
- Oscilloscope with camera, Tektronix 547 or equivalent  
7633 S/N C9121, Cal. date 2-17-77
- Current probe, Tektronix P6042 or equivalent N/A,  
S/N C7543, Cal. date 5-12-77
- DVM, H-P 3440 or equivalent HP3465A, S/N C9255,  
Cal. date 1-1-77
- Current Meter, Weston 911 or equivalent N/A,  
S/N B3217, Cal. date 1-2-77
- VOM, Simpson 270 or equivalent HP3465A,  
S/N C7255, Cal. date 1-1-77
- Precision power supply, H-P 6114A or equivalent N/A,  
S/N C-8792, Cal. date 1-22-77
- Pulse generator, Tektronix 2101 or equivalent N/A,  
S/N C 8226, Cal. date 5-10-77
- X-Y Plotter, H-P 7047A or equivalent N/A,  
S/N C8968, Cal. date 2-10-77
- Dividing Head, 2 axis, Leitz Imperial Series 72 or  
equivalent N/A, S/N B12611, Cal. date 1-12-77



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## Data Sheet 2

## 3.6.1 Self Check

Check ✓

## 3.6.2 Test Set Supply Voltages

| FUNCTION | MEASUREMENT    | REQUIREMENT |
|----------|----------------|-------------|
| +28v     | <u>0.68</u> mA | 0.7 + 0.07  |
| +12v     | <u>0.61</u> mA | 0.6 + 0.06  |
| +10v     | <u>0.48</u> mA | 0.5 + 0.05  |
| + 8v     | <u>0.82</u> mA | 0.8 + 0.08  |
| + 5v     | <u>0.50</u> mA | 0.5 + 0.05  |
| - 5v     | <u>0.54</u> mA | 0.5 + 0.05  |

## 4.1.1 Ground Continuity

| Measure from<br>Pin to Pin    | Function     | Measurement    | Requirement |
|-------------------------------|--------------|----------------|-------------|
| 20 Electronics box<br>chassis | CHASSIS GND. | <u>.04</u> Ohm | <0.2 Ohms   |
| 20 21                         | CHASSIS GND. | <u>.03</u> Ohm | <0.2 Ohms   |
| 17 19                         | 28v Ret.     | <u>.15</u> Ohm | <0.2 Ohms   |
| 12 13                         | SIG. GND.    | <u>.15</u> Ohm | <0.2 Ohms   |

## 4.1.2 Ground Isolation

| Measure from<br>Pin to Pin | Function  | Measurement        | Requirement |
|----------------------------|-----------|--------------------|-------------|
| 20 12                      | SIG. GND. | <u>&gt;10M</u> Ohm | >100 kΩ     |
| 20 17                      | 28v Ret.  | <u>&gt;10M</u> Ohm | >100 kΩ     |

## 4.2.1 Thermistor Continuity

| Measure from<br>Pin to Pin | Function                     | Measurement      | Requirement |
|----------------------------|------------------------------|------------------|-------------|
| 14 15                      | Elect. Thms. 1 ( $R_{et1}$ ) | <u>10.941</u> kΩ | 5k to 15kΩ  |
| 33 34                      | Elect. Thms. 2 ( $R_{et2}$ ) | <u>10.949</u> kΩ | 5k to 15kΩ  |
| 35 36                      | Scan. Thms. 1 ( $R_{st1}$ )  | <u>10.957</u> kΩ | 5k to 15kΩ  |
| 37 5                       | Scan. Thms. 2 ( $R_{st2}$ )  | <u>10.926</u> kΩ | 5k to 15kΩ  |

C-4



## Data Sheet 3

## 4.2.2 Electronics Thermistor Resistance

$$\Delta R = \frac{(R_{et1} - R_{et2}) \times 100\%}{R_{et1}} = \frac{(10.941 \text{ k}\Omega - 10.949 \text{ k}\Omega) \times 100\%}{10.941 \text{ k}\Omega}$$

$$R_{et1} = 0.07 \%$$

Requirement:  $\pm 4\%$ 

## 4.2.3 Scanner Thermistor Resistance

$$\Delta R = \frac{(R_{st1} - R_{st2}) \times 100\%}{R_{st1}} = \frac{(10.957 \text{ k}\Omega - 10.924 \text{ k}\Omega) \times 100\%}{10.957 \text{ k}\Omega}$$

$$R_{st1} = 0.28 \%$$

Requirement:  $\pm 4\%$ 

## 4.2.4 Thermistor Isolation

| Measure from<br>Pin to Pin |    | Function       | Measurement                | Requirement    |
|----------------------------|----|----------------|----------------------------|----------------|
| 14                         | 20 | Elect. Thms. 1 | <u>&gt;1000</u> k $\Omega$ | >100k $\Omega$ |
| 34                         | 20 | Elect. Thms. 2 | <u>&gt;1000</u> k $\Omega$ | >100k $\Omega$ |
| 35                         | 20 | Scan. Thms. 1  | <u>&gt;1000</u> k $\Omega$ | >100k $\Omega$ |
| 37                         | 20 | Scan. Thms. 2  | <u>&gt;1000</u> k $\Omega$ | >100k $\Omega$ |

## 4.3.3 Initial Turn On

Check ✓

## 4.4.3 Idle Input Current

| Function                          | Measurement    | Requirement     |
|-----------------------------------|----------------|-----------------|
| 28v input current<br>( $I_{in}$ ) | <u>51</u> mA   | 50mA $\pm$ 25mA |
| 28v input voltage<br>( $E_{in}$ ) | <u>28.03</u> V | 28V $\pm$ 0.28V |

## 4.4.4 Idle Input Power

$$P_i = E_{in} \times I_{in}$$

$$= 28.03 \text{ V} \times 51 \text{ mA}$$

$$= 1429 \text{ mW. Reference reading only.}$$



## Data Sheet 4

4.4.6 Scanner Rotation

Check ☒

4.4.7 Running Power

FunctionMeasurement28v input current  
( $I_{in}$ )27.99 mA

Reference only

28v input voltage  
( $E_{in}$ )16.8 V

Reference only

$$P_r = E_{in} \times I_{in}$$

$$= 27.99V \times 16.8 \text{ mA}$$

$$= 470.2 \text{ mW}$$

Requirement &lt;5.0 watts

4.4.11 Main Electronics Power

FunctionMeasurement28v input current  
( $I_{in}$ )35 mA

Reference only

28v input voltage  
( $E_{in}$ )28.08 V

Reference only

$$P_e = E_{in} \times I_{in}$$

$$= 28.08V \times 35 \text{ mA}$$

$$P_e = 983 \text{ mW}$$

Requirement &lt;1.0 watts

4.5 Power On Initialize

4.5.3 ☒ Check4.5.5 ☒ Check4.5.7 OFFSET =  $\frac{AOS1 + LOS1 + AOS2 + LOS2 + AOS3 + LOS3 - 1060}{6}$ 

6

OFFSET = .23Requirement: + 34.5.8 ☒ Check4.5.9 ☒ Check

**Data Sheet 5****4.6.1 Analog Telem Calibration**

| <u>Measure from</u><br><u>Pin to Pin</u> |    | <u>Function</u> | <u>Measurement</u> | <u>Requirement</u> |
|------------------------------------------|----|-----------------|--------------------|--------------------|
| 12                                       | 9  | + 5v MONITOR    | <u>4.195V</u>      | 4.0 + 1.0V         |
| 12                                       | 10 | +20v MONITOR    | <u>4.142V</u>      | 4.0 + 1.0V         |

**4.7.2 Scanner Revolution Rate**

| <u>Rate (R)</u> | <u>Rate Readout</u> | <u>Measured Time</u> | <u>Nominal Time</u> |
|-----------------|---------------------|----------------------|---------------------|
| 0               | <u>0</u>            | <u>52</u> sec.       | 52 sec.             |
| 1               | <u>1</u>            | <u>26</u> sec.       | 26 sec.             |
| 2               | <u>2</u>            | <u>13</u> sec.       | 13 sec.             |
| 3               | <u>5</u>            | <u>6.5</u> sec.      | 6.5 sec.            |

**4.8 Invalid Data Test**4.8.1 ✓ Check4.8.2 ✓ Check**4.9 CW-CCW Test**4.9.2 ✓ Check4.9.4 ✓ Check4.9.5 ✓ Check4.9.6 ✓ Check4.9.7 ✓ Check**4.10 Sector Test**4.10.2 ✓ Check4.10.3 ✓ Check4.10.4 ✓ Check4.10.5 ✓ Check4.10.6 ✓ Check4.10.7 ✓ Check4.10.8 ✓ Check4.10.9 ✓ Check4.10.10 ✓ Check



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Data Sheet 6

|         |                |
|---------|----------------|
| 4.10.11 | <u>✓</u> Check |
| 4.10.12 | <u>✓</u> Check |
| 4.10.13 | <u>✓</u> Check |
| 4.10.14 | <u>✓</u> Check |
| 4.10.15 | <u>✓</u> Check |
| 4.10.16 | <u>✓</u> Check |
| 4.10.17 | <u>✓</u> Check |
| 4.10.18 | <u>✓</u> Check |
| 4.10.19 | <u>✓</u> Check |
| 4.10.20 | <u>✓</u> Check |
| 4.10.21 | <u>✓</u> Check |
| 4.10.22 | <u>✓</u> Check |
| 4.10.23 | <u>✓</u> Check |
| 4.10.24 | <u>✓</u> Check |
| 4.10.25 | <u>✓</u> Check |
| 4.10.26 | <u>✓</u> Check |
| 4.10.27 | <u>✓</u> Check |
| 4.10.28 | <u>✓</u> Check |
| 4.10.29 | <u>✓</u> Check |
| 4.10.30 | <u>✓</u> Check |
| 4.10.31 | <u>✓</u> Check |
| 4.10.32 | <u>✓</u> Check |
| 4.10.33 | <u>✓</u> Check |
| 4.10.34 | <u>✓</u> Check |
| 4.10.35 | <u>✓</u> Check |
| 4.10.36 | <u>✓</u> Check |
| 4.10.37 | <u>✓</u> Check |





## Data Sheet 7

4.11.6 Sector Check

Check ✓

4.11.7 Power Supply Variation

POWER  
SUPPLYAOS/LOS  
DISPLAY0  
READOUT

26.60 + 0.26v (-4%)

✓✓

28.84 + 0.28v (+2%)

✓✓

28.00 + 0.28v (NOM)

✓✓

4.11.9 Clock Frequency Variations

Frequency at FailureRequirementUpper 14.7 MHz

&gt;12.9 MHz

Lower 5 MHz

&lt;10.0 MHz

4.12 Slow Data Rate

4.12.5 ✓ Check4.12.6 ✓ Check4.12.7 ✓ Check4.12.8 ✓ Check4.12.9 ✓ Check4.12.10 ✓ Check4.12.11 ✓ Check4.12.12 ✓ Check

4.13 Spherical Mode Check

4.13.4 ✓ Check4.13.5 ✓ Check4.13.6 ✓ Check4.13.7 ✓ Check4.13.8 ✓ Check4.13.9 ✓ Check4.13.10 ✓ Check



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REV \_\_\_\_\_

**Data Sheet 8**

|         |                |
|---------|----------------|
| 4.13.11 | <u>✓</u> Check |
| 4.13.12 | <u>✓</u> Check |
| 4.13.13 | <u>✓</u> Check |
| 4.13.14 | <u>✓</u> Check |
| 4.13.15 | <u>✓</u> Check |
| 4.13.16 | <u>✓</u> Check |
| 4.13.17 | <u>✓</u> Check |
| 4.13.18 | <u>✓</u> Check |
| 4.13.19 | <u>✓</u> Check |
| 4.13.20 | <u>✓</u> Check |
| 4.13.21 | <u>✓</u> Check |
| 4.13.22 | <u>✓</u> Check |
| 4.13.23 | <u>✓</u> Check |
| 4.13.24 | <u>✓</u> Check |
| 4.13.25 | <u>✓</u> Check |
| 4.13.26 | <u>✓</u> Check |
| 4.13.27 | <u>✓</u> Check |
| 4.13.28 | <u>✓</u> Check |
| 4.13.29 | <u>✓</u> Check |
| 4.13.30 | <u>✓</u> Check |
| 4.13.31 | <u>✓</u> Check |
| 4.13.32 | <u>✓</u> Check |
| 4.13.33 | <u>✓</u> Check |
| 4.13.34 | <u>✓</u> Check |
| 4.13.35 | <u>✓</u> Check |
| 4.13.36 | <u>✓</u> Check |



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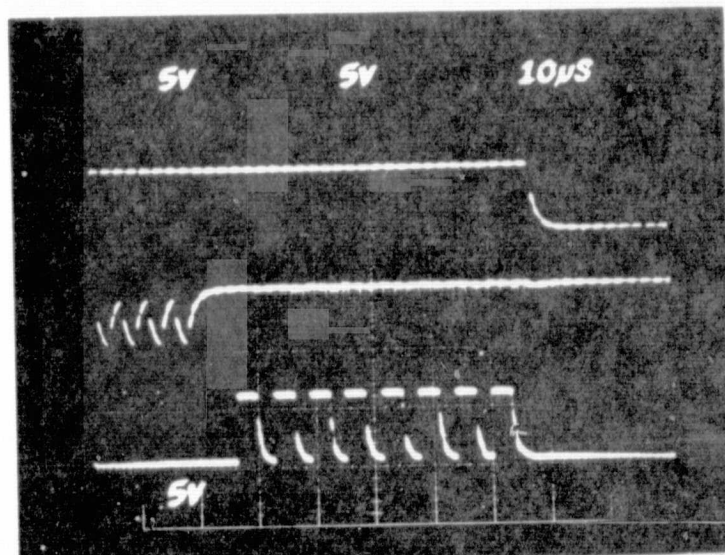
CODE IDENT NO 13993

SHEET 62

Data Sheet 9

4.14.2

5v/cm  
5v/cm  
5v/cm  
10μs/cm



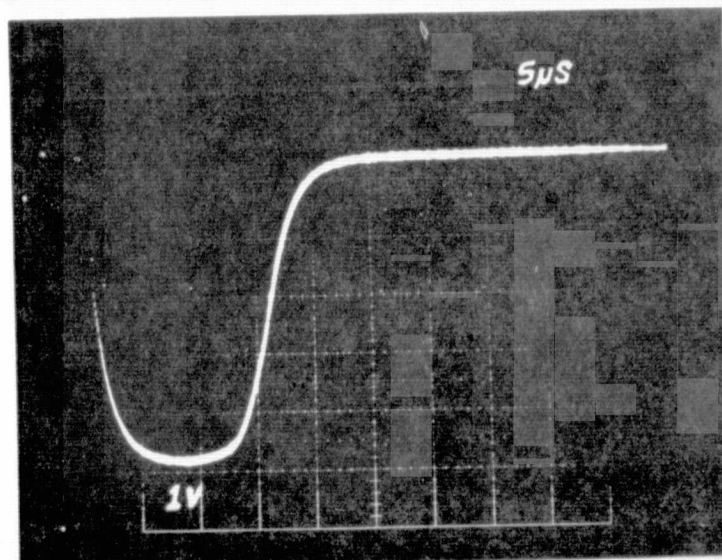
DWG

Burst  
Clock

Shift  
Pulses

4.14.6

1v/cm  
5μs/cm



Load  
Pulse

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DATE

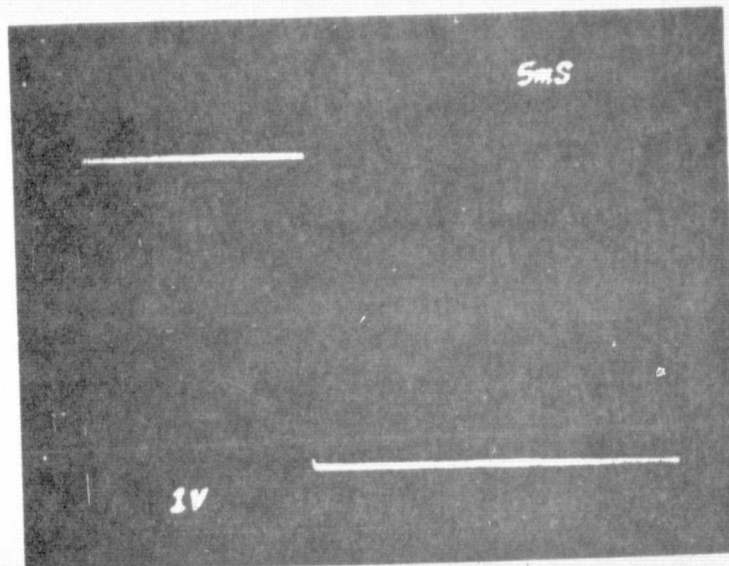
REV

Data Sheet 10

4.14.11

1v/cm

5ms/cm

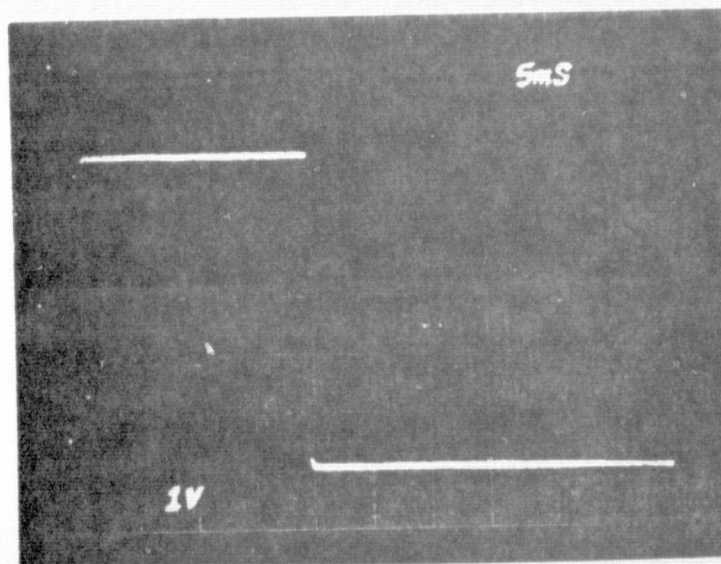


Sun  
Slit  
#1

4.14.14

1v/cm

5ms/cm



Sun  
Slit  
#2

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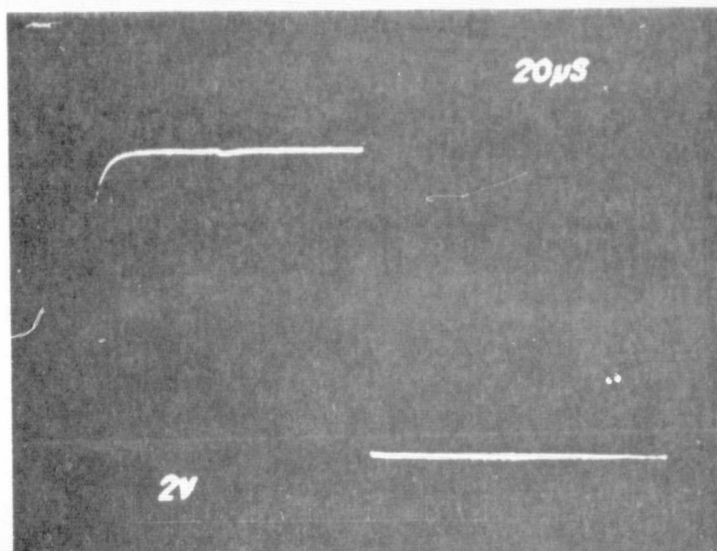
SHEET 64 REV

Data Sheet 11

4.14.17

2v/cm

20ms/cm



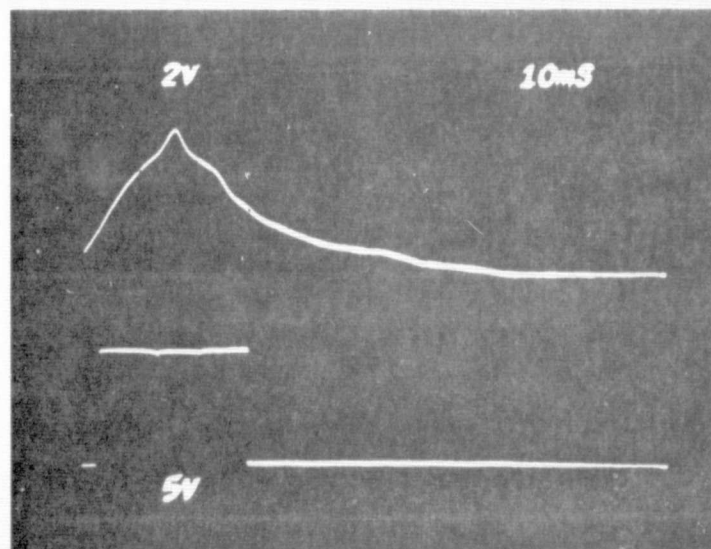
10v  
Sun  
Pulse

4.14.21

2v/cm

5v/cm

10ms/cm



Sun  
Slit  
Analog

Sun  
Slit





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SHEET 65 REV

Data Sheet 12

4.14.22 Sun Slit Amplitude

$V_{pk} = 5.5$  volts Reference only

$\frac{V_{pk}}{2} = \frac{5.5}{2} = 2.75$  volts Reference only

4.14.23 Sun Slit Failure Edge

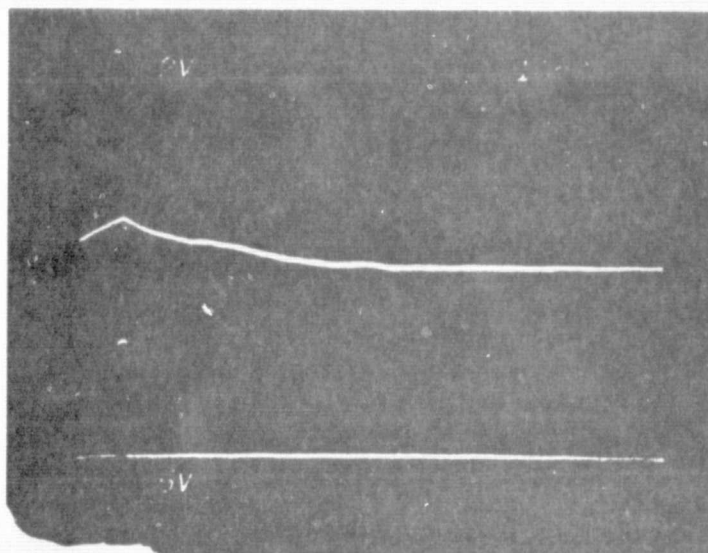
$2.5$  Volts, Requirement:  $\frac{V_{pk}}{2} \pm 0.5V$

4.14.24 Minimum Threshold Photo

2v/cm

5v/cm

5ms/cm



Sun Slit  
Analog

Sun  
Slit

4.14.25 Minimum Threshold Measurement

$2.2$  Volts, Requirement  $2.25 \pm 0.5V$

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SHEET 66 REV

### Data Sheet 13

#### 4.14.28 Motor Drive Pulses

20v/cm

20V

20V

5ms

$\phi A$

$\phi B$

$\phi C$

$\phi D$

5ms/cm

20V

20V

#### 4.14.33 $\phi A$ Current Photograph

100mA/cm

50mV

>5ms

$\phi A$  motor  
current

10v/cm

~6ms/cm

10V

$\phi A$  motor  
voltage



Data Sheet 14

4.14.35  $\Phi A$  Current Measurement

Measurement

260 mA

Requirement

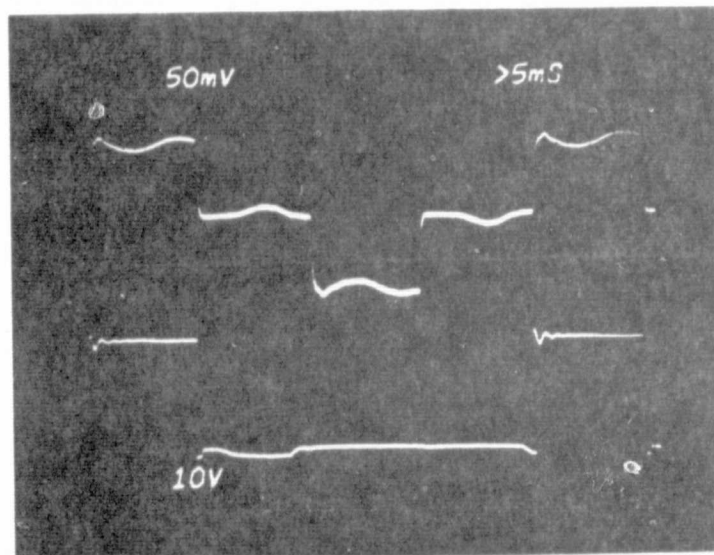
300 mA max excluding spikes

4.14.37  $\Phi B$  Current Photograph

100mA/cm

10v/cm

6ms/cm



$\Phi A$  motor  
voltage

$\Phi B$  motor  
current

4.14.38  $\Phi B$  Current Measurement

Measurement

260 mA

Requirement

300 mA max excluding spikes

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SHEET 68 REV A

## Data Sheet 15

4.15.7

Transcribe the 2-axis table settings and complete the following table.

| Tilt Angle (degrees) | Peak Amplitude (volts) | (1)<br>-Az Angle at 1/2 PK Amp (degrees) | (2)<br>+Az Angle at 1/2 PK Amp (degrees) |
|----------------------|------------------------|------------------------------------------|------------------------------------------|
| +1.00                | —                      | —                                        | —                                        |
| 0.75                 | —                      | —                                        | —                                        |
| 0.50                 | 0.90                   | -92                                      | +90                                      |
| 0.25                 | 2.60                   | -91                                      | +91                                      |
| 0.0                  | 3.60                   | -92                                      | +90                                      |
| -0.25                | 2.45                   | -91                                      | +90                                      |
| -0.50                | 0.94                   | -92                                      | +90                                      |
| -0.75                | —                      | —                                        | —                                        |
| -1.00                | —                      | —                                        | —                                        |

The sun sensor field of view (Column 1 - Column 2) in the azimuth axis shall be  $180^\circ \pm 12^\circ$  at 50% of the peak amplitude at the peak amplitude tilt angle.

☒ Check



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SHEET 69 REV A

### Data Sheet 16

4.15.8, 10

Transcribe the 2-axis table settings and complete the following table.

| Azimuth<br>Angle<br>(degrees) | Space Corrected<br>Peak<br>Amplitude<br>(volts) | (1)<br>-Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | (2)<br>+Tilt Angle<br>at 1/2 PK Amp<br>(degrees) | F.O.V.<br>(degrees)       |
|-------------------------------|-------------------------------------------------|--------------------------------------------------|--------------------------------------------------|---------------------------|
|                               |                                                 |                                                  |                                                  |                           |
| -85                           | 4.87                                            | $\epsilon^- = -0.467$                            | $\epsilon^+ = +0.267$                            | .733 Jan<br>0.467 12/2/76 |
| -45                           | 6.17                                            | $-0.250$                                         | $+0.250$                                         | 0.500                     |
| 0                             | 6.75                                            | $\xi^- = -0.358$                                 | $\xi^+ = +0.308$                                 | 0.667                     |
| +45                           | 6.37                                            | $-0.383$                                         | $+0.300$                                         | .683 Jan<br>0.783 12/2/76 |
| 85                            | 5.58                                            | $\eta^- = -0.400$                                | $\eta^+ = +0.309$                                | 0.709                     |

The sun sensor field of view (|column 1 - column 2|) in the elevation (tilt) axis shall be  $0.5 \pm 0.1^\circ$  at 50% of the peak amplitude

59

Check

S<sub>22</sub> MDR #A30555

The tilt angle,  $\rho$  of the sun slit is defined as the angle between the Z-axis and the line formed by the intersection of the sun slit FOV plane and the plane containing the Y and Z axis.  $\rho$  is more positive as it rotates from the +Z axis toward the +Y axis.

Calculate the sun slit tilt angle ( $\rho$  in Figure 13) using the following equation:

$$\rho = \frac{(\xi^- + \xi^+)}{2}$$

$$= -0.025^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

The rotation angle,  $\psi$ , of the sun slit is defined as the angle between the X-axis and the intersection of the sun slit FOV plane and the plane containing the X and Y axis.  $\psi$  is more positive as it rotates from the +X axis toward the -Y axis.

Calculate the sun slit rotation angle ( $\psi$  in Figure 13) using the following equation:

$$\psi = \frac{(\epsilon_+ + \epsilon_- + \eta_- + \eta_+)}{4}$$

$$= 0.027^\circ$$

Requirement

$$0.0 \pm 2.0^\circ$$

Falling Edge Trip Point Offset

$$0.308^\circ$$

Reference Only





## Data Sheet 17

4.16.7

- Transcribe the 2-axis table settings and complete the following table and calculate the Azimuth Field of View (FOV = | column 4 - column 3 |).

| Scanner<br>Encoded<br>Position | Reference<br>Angle | Negative<br>Azimuth Angle<br>1/2 Pk. Amp. | Positive<br>Azimuth Angle<br>1/2 Pk. Amp. | Azimuth<br>FOV*                 | Require-<br>ment      |
|--------------------------------|--------------------|-------------------------------------------|-------------------------------------------|---------------------------------|-----------------------|
| 000                            | 0° (x-axis)        | $\alpha_1 = -0.276$                       | $\alpha_2 = 0.429$                        | $ \alpha_2 - \alpha_1  = 0.705$ | $0.71 \pm 0.05^\circ$ |
| 128                            | 90°                | $\beta_1 = -0.275$                        | $\beta_2 = 0.430$                         | $ \beta_2 - \beta_1  = 0.705$   | $0.71 \pm 0.05^\circ$ |
| 256                            | 180°               | $\gamma_1 = -0.269$                       | $\gamma_2 = 0.436$                        | $ \gamma_2 - \gamma_1  = 0.705$ | $0.71 \pm 0.05^\circ$ |
| 384                            | 270° (y-axis)      | $\delta_1 = -0.301$                       | $\delta_2 = 0.404$                        | $ \delta_2 - \delta_1  = 0.705$ | $0.71 \pm 0.05^\circ$ |

\* The scanner Field of View shall be  $0.71^\circ \pm 0.05^\circ$  at 50% of the peak amplitude.

- Calculate the Zero Scan Angle Error using the following equation:

$$\text{Error} = \frac{|\alpha_2 + \alpha_1|}{2}$$

$$\text{Error} = \underline{0.077}^\circ \quad \text{Requirement} \quad 0^\circ \pm 0.7^\circ$$

- Calculate the scanner position accuracy according to the equations below:

| Encoder<br>Position | Reference<br>Angle | Error                                                          | Requirement     |
|---------------------|--------------------|----------------------------------------------------------------|-----------------|
| 128                 | 90°                | $(\alpha_1 + \alpha_2 - \beta_1 - \beta_2)/2 = -0.001^\circ$   | $\pm 0.1^\circ$ |
| 256                 | 180°               | $(\alpha_1 + \alpha_2 - \gamma_1 - \gamma_2)/2 = -0.007^\circ$ | $\pm 0.1^\circ$ |
| 384                 | 270°               | $(\alpha_1 + \alpha_2 - \delta_1 - \delta_2)/2 = 0.026^\circ$  | $\pm 0.1^\circ$ |



## Data Sheet 18

4.16.9

- Transcribe the 2-axis table readings to the following table and calculate the Elevation Field of View (FOV= |column 4 - column 3|).

| Scanner Encoded Position | Reference Angle | Negative Elevation Angle<br>1/2 Pk. amp | Positive Elevation Angle<br>1/2 Pk. amp | Elevation FOV*                  | Requirement           |
|--------------------------|-----------------|-----------------------------------------|-----------------------------------------|---------------------------------|-----------------------|
| 000                      | 0° (x-axis)     | $\alpha_- = -0.550$                     | $\alpha_+ = 0.150$                      | $ \alpha_+ - \alpha_-  = 0.700$ | $0.71 \pm 0.05^\circ$ |
| 128                      | 90°             | $\beta_- = -0.550$                      | $\beta_+ = 0.167$                       | $ \beta_+ - \beta_-  = 0.717$   | $0.71 \pm 0.05^\circ$ |
| 256                      | 180°            | $\gamma_- = -0.550$                     | $\gamma_+ = 0.167$                      | $ \gamma_+ - \gamma_-  = 0.717$ | $0.71 \pm 0.05^\circ$ |
| 384                      | 270° (y-axis)   | $\delta_- = -0.567$                     | $\delta_+ = 0.150$                      | $ \delta_+ - \delta_-  = 0.717$ | $0.71 \pm 0.05^\circ$ |

\*The scanner field of view shall be  $0.71^\circ \pm 0.05^\circ$  at 50% of the peak amplitude.

- Calculate the tilt angle ( $\phi$  in Figure 13) of the plane of the scanner optical axis with respect to the plane of the mounting surface using the following equation.

$$\phi = \tan^{-1} \left( \frac{|\sqrt{\alpha^2 + \beta^2 + \gamma^2 + \delta^2 - 2\alpha\gamma - 2\beta\delta}|}{2} \right)$$

$$\text{where; } \alpha = \tan (\alpha_+ + \alpha_-) / 2$$

$$\beta = \tan (\beta_+ + \beta_-) / 2$$

$$\gamma = \tan (\gamma_+ + \gamma_-) / 2$$

$$\delta = \tan (\delta_+ + \delta_-) / 2$$

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$$\phi = 0.009^\circ$$

Requirement

$$0^\circ \pm 2.0$$

- Calculate the direction of maximum tilt response with respect to the zero reference angle ( $\theta$  in Figure 13) using the following equation:

$$\theta = \tan^{-1} \frac{(\delta - \beta)}{(\gamma - \alpha)} - \left| \frac{(\delta - \beta)}{(\delta - \beta)} \frac{(\gamma - \alpha)}{(\gamma - \alpha)} \right| \cdot 90^\circ - \left| \frac{(\delta - \beta)}{(\delta - \beta)} \right| \cdot 90^\circ + 180^\circ \quad \text{Reference only}$$

$$\theta = 296.553^\circ$$



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Data Sheet 19

- Calculate the cone angle (average deviation from a plane) using the following equation:

$$\phi = \frac{(\alpha_- + \alpha_+ + \beta_- + \beta_+ + \gamma_- + \gamma_+ + \delta_- + \delta_+)}{8}$$

$$\phi = -0.198^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

- Calculate the maximum error using the following equation:

$$\text{error} = |\phi| + |\phi| = 0.207^\circ$$

Requirement

$$0^\circ \pm 2.0^\circ$$

4.16.13 Scanner Trip-On Point

Measured  $V_{\text{trip-on}}$

$$9.078 \text{ V}$$

Measured  $V_{\text{dark}}$

$$8.999 \text{ V}$$

% full space moon =

$$\frac{V_{\text{trip-on}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 8.06\%$$

Requirement

5% to 20%

4.16.15 Scanner Trip-Off Point

Measured  $V_{\text{trip-off}}$

$$9.074 \text{ V}$$

Measured  $V_{\text{dark}}$

$$8.999 \text{ V}$$

% full space moon =

$$\frac{V_{\text{trip-off}} - V_{\text{dark}}}{0.980} \times 100\%$$

$$= 7.65\%$$

Requirement

5% to 20%

4.17.7 Backlash Test

Measured

$$0.083^\circ$$

Requirement

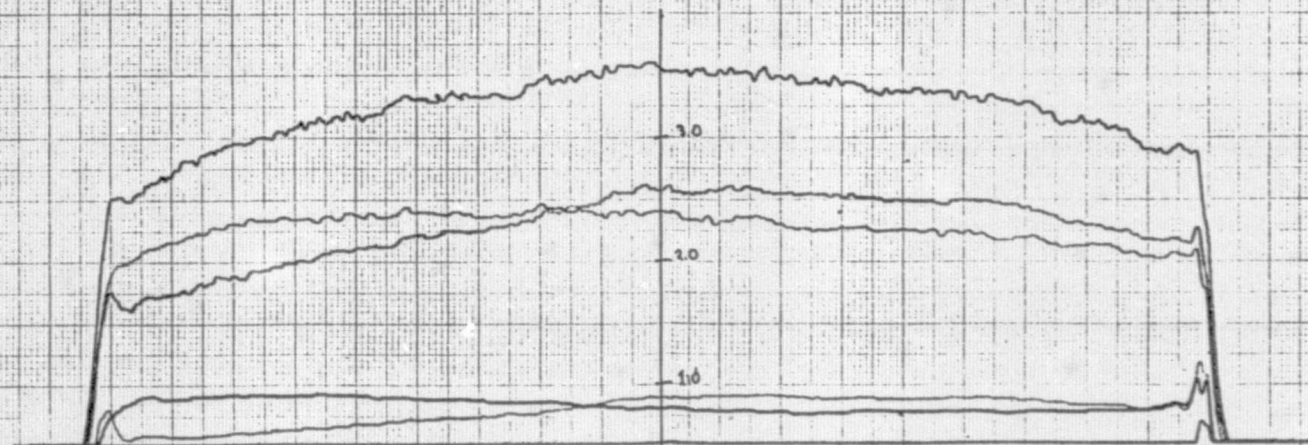
$$<0.2^\circ$$

# SENSOR DATA BLOCK

6-1

|                                            |               |
|--------------------------------------------|---------------|
| BLOCK S/N: 006                             | DATE: 12-1-76 |
| SENSOR: PAS                                |               |
| DESC: F.P.T.                               |               |
| SUN SLIT                                   | TEMP:         |
| SENSOR PEAK:                               |               |
| SOLAR PEAK:                                |               |
| SPACE PEAK:                                |               |
| SPACE GAIN:                                | NULL:         |
| X FULL SCALE: 10°/div Y FULL SCALE: 1V/div |               |

0° BCK STD 1.89  
 +25° Red STD 1.89  
 +50° narrow STD 1.90  
 -25° GRN STD 1.90  
 -50° BLU STD 1.90



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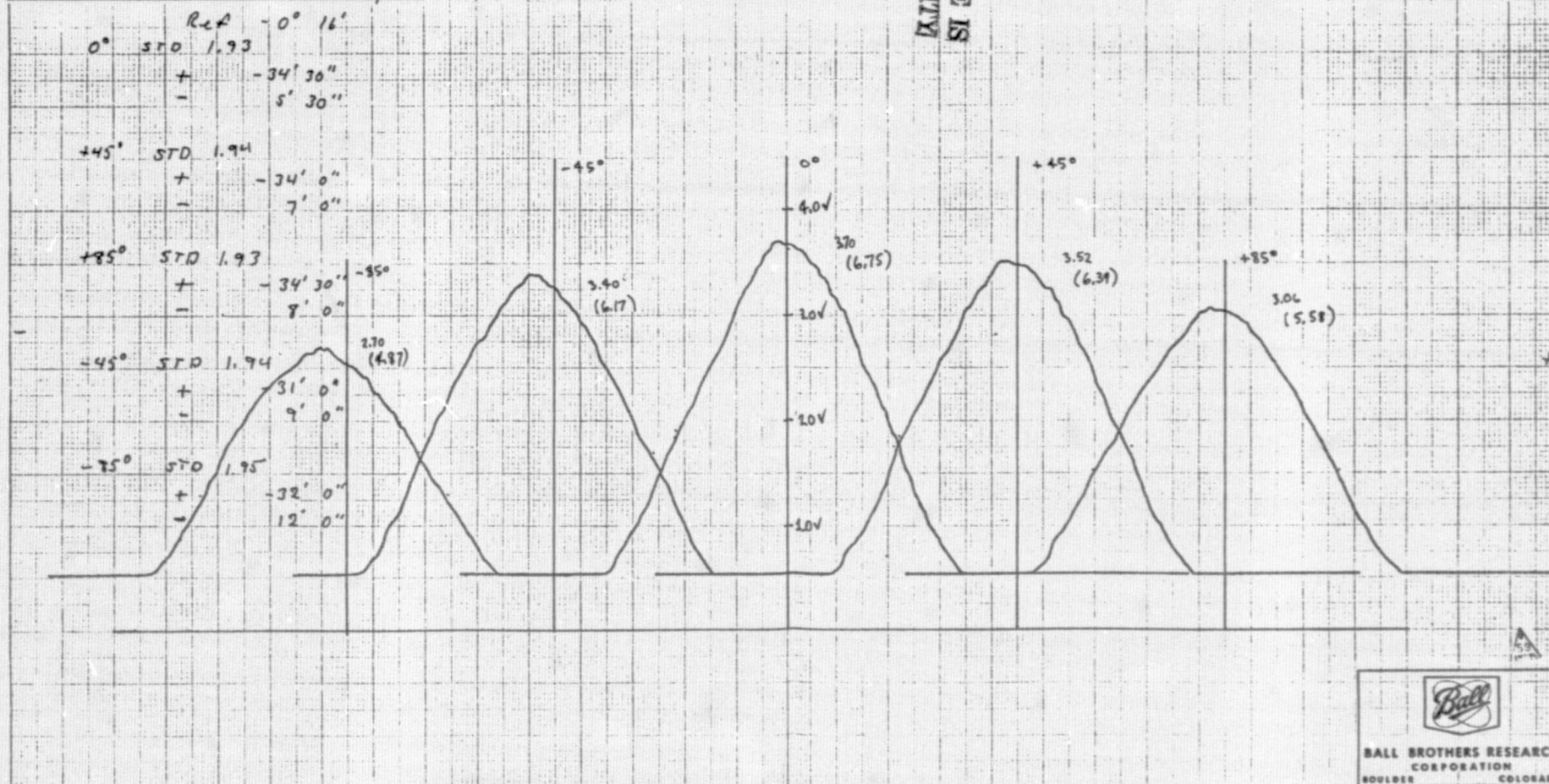


# SENSOR DATA BLOCK

6-2

|                                          |       |               |
|------------------------------------------|-------|---------------|
| BLOCK S/N: 006                           |       | DATE: 12-1-76 |
| SENSOR: PAS                              |       |               |
| DESC: F.P.T                              |       |               |
| SUN SLIT                                 | TEMP: |               |
| SENSOR PEAK:                             |       |               |
| SOLAR PEAK:                              |       |               |
| SPACE PEAK:                              |       |               |
| SPACE GAIN:                              | NULL: |               |
| X FULL SCALE: 10°/IN Y FULL SCALE: 1V/IN |       |               |

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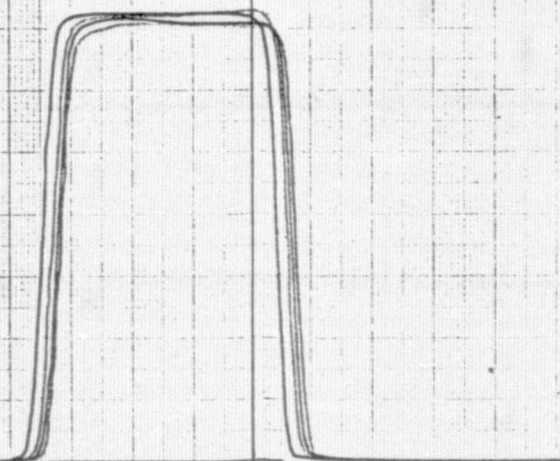
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## 6-3

|               |          |               |          |
|---------------|----------|---------------|----------|
| BLOCK S/N:    | 006      | DATE:         | 11-30-74 |
| SENSOR:       | P.A.S.   |               |          |
| DESC:         | F.P.T.   |               |          |
| SCANNED EL    |          | TEMP:         |          |
| SENSOR PEAK:  |          |               |          |
| SOLAR PEAK:   |          |               |          |
| SPACE PEAK:   |          |               |          |
| SPACE GAIN:   |          | NULL:         |          |
| X FULL SCALE: | 10' / in | Y FULL SCALE: | 10' / in |

Ref 3° 9'

$$0^{\circ} \text{ BLK} - 2^{\circ} 36'$$
$$+ 3^{\circ} 18'$$
$$\begin{array}{r} 90^{\circ} \text{ Red} - 2^{\circ} 36' \\ + 3^{\circ} 19' \end{array}$$
$$180^{\circ} \text{GRN} - 2^{\circ} 36' + 3^{\circ} 19'$$
$$270^\circ \text{ PLU } -2^\circ 35'$$
$$+3^\circ 18'$$


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# SENSOR DATA BLOCK

6-4

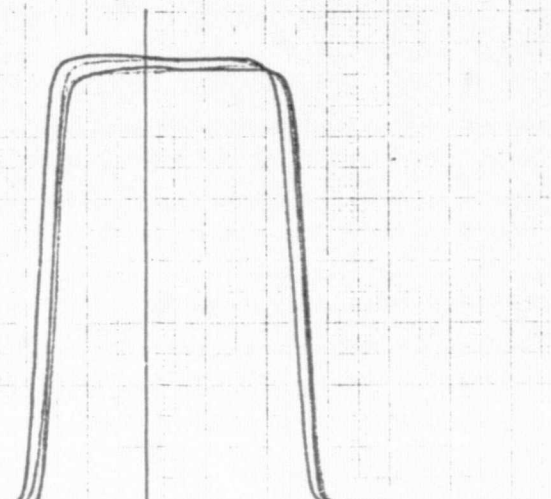
|                                               |                |
|-----------------------------------------------|----------------|
| BLOCK S/N: 006                                | DATE: 11-30-76 |
| SENSOR: PAS                                   |                |
| DESC: F.P.T                                   |                |
| SCANNER: A3                                   | TEMP:          |
| SENSOR PEAK:                                  |                |
| SOLAR PEAK:                                   |                |
| SPACE PEAK:                                   |                |
| SPACE GAIN:                                   | NULL:          |
| X FULL SCALE: 10' / 4.0V FULL SCALE: 10V / IN |                |

0° BLK Ref 220° 00' 00"  
 - 219° 43' 28"  
 + 220° 25' 45"

90° Red Ref 310° 00' 00"  
 - 307° 43' 29"  
 + 310° 25' 48"

180° GRN Ref 40° 00' 00"  
 39° 43' 52"  
 40° 26' 09"

270° BLU Ref 130° 00' 00"  
 - 129° 41' 55"  
 + 130° 24' 13"



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